THE ECOLOGY OF THE UPPER WILLIAMS RIVER AND BARRINGTON TOPS DISTRICTS. II.

THE RAIN-FOREST FORMATIONS.

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(Plates vii–xiii.)

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The Sub-Tropical Rain-Forest: Method of Study; Distribution; Composition; Structure; The Rain-Forest Margin; Outliers; Regeneration; Special Features; Allied Rain-Forest Areas; Rain-Forest Outliers to the east and west of the Plateau.

The Sub-Antarctic Rain-Forest (Beech Forest): Distribution; Composition; Structure; The Margins of the Sub-antarctic Rain-Forest.

Discussion and Conclusions: Distribution; Structure; Composition and Comparison with other Rain-Forest Areas in N.S.W.; Ecological Relationships; Distribution of Species.

The Sub-Tropical Rain-Forest.

Method of Study.

(*a*) *Composition.*—Before any comprehensive work could be done on the structure of the rain-forest or the distribution of species within it, it was necessary to become familiar with the habit, leaves and bark of the commonly-occurring species, so that all except a small fraction could be identified in the field at once.

(*b*) *Structure.*—The difficulty of study in a sub-tropical rain-forest is due to its vertical extent and density, and the very large number of species of trees present. Since one can see a short distance only within the forest and many of the component trees have a very similar appearance, the observer cannot at once gain from a general survey any idea of the distribution of species in it. At first sight it appears relatively homogeneous, the trees being more or less evenly distributed, the chief differences apparently being due to variations in the ground flora. A preliminary survey was made along routes chosen at random through areas of forest growing under uniform conditions. The results indicated at once that the individual species were not evenly distributed. The following method of sampling was therefore adopted to demonstrate this variation in structure: An area of rain-forest, one to several acres in extent, was chosen at random with the same general habitat and showing no observable differences due to special causes. Within this area 10–25 circular plots of 10 feet radius were chosen, again at random. Within each plot all large plants were counted, and their heights and diameters recorded. When ferns were present in the ground stratum they were indicated as numerous, scanty, or rare. By this method it was possible to obtain an idea of the relative abundance and importance of any species in any one area, and, by comparing records from different localities, to arrive at a conclusion as to the distribution and density of any one species and the relation of species to specialized habitats, such as river banks. Both sub-tropical and sub-antarctic rain-forests were analysed in this way. Once the general features had thus been determined in a part of the forest, it was found possible to supplement the

knowledge thus gained by direct observations over larger areas, in the light of these conclusions.

The structure of rain-forest margins, and river and creek floras, was noted from time to time wherever changes were apparent, and relevant data regarding aspect were recorded.

The heights of trees were calculated by means of an Abney level where possible. Elsewhere they were estimated by comparison with the more or less standard layers of the canopy.

(*c*) *Distribution.*—It was not possible to map in detail the boundaries of the Williams and Allyn River rain-forests, but it was necessary to define the factors which determined the extent of the rain-forest in special areas. Consequently the altitudes of the margins of the formation were recorded and compared in cases which illustrated the influence of certain factors, e.g., on either bank of the main river, either side of the Williams–Allyn Divide, and up the sides of creeks.

Distribution.

The margin of the rain-forest is very well defined and no difficulty is found in tracing its boundaries. These are shown approximately in Map 1, Part 1 (These Proc., 1937, p. 272). On the north-east side of the Williams Range the rain-forest extends 500 to 600 feet higher than on the south-west side. In the sheltered beds of creeks, however, the rain-forest on the south-western side approaches that on the north-east side. In several places where a depression in the ridge marks the heads of two creeks, one on either side of the range, the outlier species of the rain-forest on both sides of the ridge form a common community, and in time the forest will extend completely over the ridge, especially if a high part of the range to the west provides some degree of shelter and an accumulation of soakage.

In the lower part of the Williams River valley, at the lower limit of the rain-forest, the margin on the east-facing side of the valley is 200 feet below that on the west-facing side. This is probably due to the fact that on the western side the valley is more flat than on the eastern, so that the eastern side is damper, due to soakage, and this factor appears to be of more importance in the distribution of rain-forest species than does the slightly greater amount of shelter obtaining on the western side.

Composition.

A list of all Angiosperm and Fern species which have been found in the sub-tropical rain-forest is given in Table 1. It is probably incomplete, but any species not included must be of rare occurrence. The flora of the rain-forest includes trees, lianes, shrubs, epiphytes, and herbaceous plants. A large number of families is represented, but the number of species belonging to each is small. It can be seen that the number of species belonging to the Pteridophytes is large (35); next in abundance are the orchids (15), species of the Myrtaceae (12), and Lauraceae (9).

Structure.

(*a*) *Stratification.*

The sub-tropical rain-forest is predominantly a tree formation, and the tree strata are the most conspicuous and continuous. Stratification of the component species of the rain-forest, the importance of which has been much emphasized by workers in tropical rain-forests elsewhere, does not appear at first sight to be strongly marked in the Williams River rain-forest. This is due to the discontinuous nature of the lower strata and to the occurrence of large numbers of tree

seedlings and saplings showing a complete range of height from a few inches to maturity. The following strata, however, can be distinguished.

In the mature rain-forest the main tree-stratum has a height of 60–80 feet, occasionally 100 feet (Pl. vii, fig. 1). It is not, however, a level attained by all trees equally. Well-grown trees of *Ficus Henneana*, *Dysoxylum Fraseranum*, *Diploglottis Cunninghamii* and others frequently stand out well above the general level, so that the upper level of the canopy is most uneven. The members of this stratum characteristically have laurel-like leaves. Drip tips are common and pulvini almost universal. All species except *Cedrela australis*, *Ehretia acuminata*, and *Ficus Henneana* (Meliaceae, Boraginaceae and Moraceae respectively) are evergreen. The lower level of the canopy is high above the ground, few leaves being produced from the lower parts of the trunks. The actual canopy, therefore, though very dense, may not be very deep (20–40 feet).

Until their foliage reaches the level of the canopy the trunks of young trees are very thin and the spread of their canopy is small. Often a young tree 40 feet high may have, at three feet from the ground, a diameter of only 3 inches (Pl. vii, fig. 1; xiii, figs. 54, 55). Practically every tree carries a heavy load of epiphytes (Pl. xiii, figs. 56, 58). These are especially abundant on the taller trees which extend slightly above the general level of the canopy and whose branches in consequence probably receive more light than below the canopy. Lianes are also numerous (Pl. vii, fig. 1; viii, figs. 15, 16; xiii, fig. 56) and bind the tree tops together, thus considerably increasing the density of the canopy (Pl. viii, figs. 13, 14). The stems of the lianes often form tangled masses on the forest floor (Pl. xiii, fig. 53).

The canopy of the tree layer causes a very great decrease in the light intensity below it (Pl. vii, fig. 1). It allows through a subdued light only and small flecks of sunlight.

In many places above the canopy of the tallest rain-forest trees rise the trunks of trees belonging to a discontinuous uppermost stratum (Pl. vii, figs. 3, 4; viii, fig. 12). These trees belong to the species *Eucalyptus saligna* and *Syncarpia laurifolia*. Mature specimens of *E. saligna* measure 5–6 feet in diameter at 6 feet from the ground (Pl. vii, fig. 3; xiii, fig. 55) and attain a height of 130–170 feet with a lateral spread of 50–60 feet. *Syncarpia* is usually slightly smaller than *E. saligna* in diameter, height and spread. Mature specimens of both species have a straight trunk rising above the level of the rain-forest canopy before the lowest branch. Their distribution is discontinuous. *Syncarpia* is relatively abundant in certain localities and absent from others. *E. saligna* is also more numerous in some places than others, but is present throughout most of the forest except in the very deepest creeks, and is generally abundant. As far as could be seen, the distribution of each species is completely independent. Their foliage forms a discontinuous and rather thin canopy, well above the level of the main rain-forest trees. They probably cause little effectual diminution of light to the forest beneath them. Few of the members of this uppermost stratum carry lianes, the only common species being *Lyonsia straminea*. Epiphytes, except for *Cymbidium* on *Eucalyptus*, are very rare. The species *Syncarpia laurifolia* and *Eucalyptus saligna* extend beyond the limits of the rain-forest into the adjacent Eucalypt forest, where in places they constitute the dominant association.

Below the level of the main rain-forest canopy is a small tree stratum including such species as *Diospyros Cargillia*, *Drimys insipida*, *Eupomatia laurina*, *Wilkiea macrophylla*, *Evodia micrococca* var. *pubescens*, and sometimes *Psychotria*

loniceroides (Pl. xiii, figs. 54, 56) and the tree-fern *Alsophila Leichhardtiana* (Pl. vii, fig. 2). This stratum attains a height of 15–30 feet.

Below this is a shrub stratum including species 3–15 feet in height. Most abundant in this is *Citriobatus multiflorus* at the lower levels, and *Drimys insipida* at the upper. These two layers grade into each other completely; species which mature sufficiently to flower and fruit at 6 feet also attain a height of 20 feet. There is, however, a certain concentration at about 5 feet (*Citriobatus*), at 12 feet (*Drimys*, *Wilkiea* and *Eupomatia*), and at 25–30 feet (*Drimys*, *Diospyros* and *Evodia*). Both the small tree and the shrub strata are discontinuous and scanty (Pl. vii, fig. 1), never forming complete layers. The undergrowth is specially sparse below the Eucalypts where, though the canopy may be lighter, there is always a very considerable accumulation of decaying bark and sticks. In these strata must be included tree saplings of all sizes, which are very numerous, and at this stage have very thin stems and few leaves, e.g., a sapling of *Daphnandra micrantha* or *Cryptocarya obovata* 15 feet high may have as few as 24 leaves of laurel-leaf size, the number increasing as the canopy is neared.

The ground stratum comprises mostly ferns and perennial herbs, together with a number of seedlings, and extends upwards to a height of 3 feet. In the mature forest (Pl. vii, figs. 1, 2; xiii, figs. 53, 54) this layer is discontinuous. It is best developed in the moister parts of the forest. Common examples in the dense rain-forest are *Dryopteris decomposita*, *Athyrium umbrosum*, *Adiantum formosum*, *A. affine* and *A. hispidulum*, together with straggling plants such as *Galium*, *Pollia* and *Aneilema*. The two commonest species throughout the forest are the fern *Dryopteris decomposita* and *Lomandra montana*.

The high humidity below the main canopy encourages the growth of Bryophytes and of foliose and crustose lichens. Stones near the river bed and fallen logs (Pl. viii, fig. 17) are covered by a thick layer of mosses and liverworts, the latter being found wherever the substratum is continuously very moist. Mosses are less common on the actual ground surface because of the accumulation of litter, but occasional dense stands of *Dawsonia superba* Grev. (Pl. xiii, fig. 57) and *D. polytrichoides* R.Br. occur, especially on moist banks. The tree trunks are clothed by mosses and crustose lichens, especially the older trees (Pl. vii, fig. 2; xiii, figs. 56, 59).

(*b*) *Inherent Variability.*

The tree stratum is the most important in the forest and has received the greatest amount of attention in this study. Within it considerable variation takes place in local composition and in density. This may in places be due to special habitats such as river banks or soakage areas. But when all these factors are taken into account, there remains a variation which does not seem to be explainable on any other basis than that of chance.

This haphazard arrangement is illustrated in Tables 2, 3 and 4, which give the results of 12 sets of quadrats in mature forest, as far as possible avoiding obvious differences of soil, exposure to desiccation and light. It can be seen from this that the commonest species occur in the greatest number of localities, but that they may be much more numerous in some areas than in others. Some of the less common species are common in one locality but are absent entirely from another.

No species can be said to be dominant over the whole of the rain-forest or any considerable part of it. The highest grade of community appears to be the society (as used by Clements, 1916) which emerges occasionally in special habitats over

very small areas. Within the mature rain-forest, however, no species attain sufficient dominance to be said to mark a consociation.

There appears to be no relationship between the relative abundance of any one species and the abundance of any other species in any area. Distribution of each species is quite independent and no definite associations between species could be traced. In one locality, for example, *Schizomeria ovata* and *Sideroxylon australe* were found to be equally abundant, and in another locality where one was abundant the other was lacking or rare. The same condition holds for lianes (Table 3), epiphytes, shrubs (Table 2) and ground flora (Table 4), with the exception of a few species whose distribution will be considered in detail later. It can be seen also that the total number of saplings, shrubs and seedlings is greatly in excess of the total number of trees. The frequency and distribution of all species are indicated in Table 1.

Although no one species of tree can be said to be dominant in any area, the shrubs are not so evenly distributed. *Citriobatus multiflorus* and *Drimys insipida* are dominants in the small tree and shrub strata, *Psychotria loniceroides, Eupomatia laurina* and others being much less common. The distribution of the ground flora is more closely related to the environment than that of the trees and shrubs.

(*c*) *Variability due to the Environment.*

Within the mixed rain-forest occur communities of certain species which are characteristic of specific habitats. These form local variations in the rain-forest.

The factors which govern their distribution are light and moisture. The habitats which present conditions slightly different from those in the forest are: (1) lighter and moister, e.g. river banks (Pl. viii, figs. 13, 14, 15); (2) lighter, e.g. due to breaks in the canopy (Pl. vii, figs. 6, 7); (3) moister but not lighter, e.g. soakage areas such as occur at the base of slopes and along the courses of very small creeks (Pl. vii, fig. 8; viii, figs. 16, 17). Swampy patches in the floor of the valley at the bases of the spurs or near the main river are not uncommon. The characteristic plants of these special habitats are as follows:

(1) *Lighter and moister: Weinmannia rubifolia, Alectryon subcinereus, Backhousia myrtifolia, Callicoma serratifolia, Pittosporum undulatum, Tristania laurina, Aneilema acuminatum, Asplenium bulbiferum, Colocasia macrorrhiza, Doodia caudata, Elatostemma reticulatum, Dicksonia antarctica* (Pl. viii, fig. 15), *Lobelia trigonocaulis, Pollia crispata, Pollinia nuda, Lomandra longifolia, L. Hystrix, Oplismenus imbecillus, Urtica incisa, Stellaria flaccida, Viola hederacea, Solanum laciniatum, Diplazium japonicum, Dryopteris acuminata, Galium* spp., *Hydrocotyle hirta, Cardamine hirsuta* var. *tenuifolia.*

The large rivers make a sufficient break to allow light into the forest and along their banks light- and water-loving plants are present in greater numbers, mingled with ordinary members of the rain-forest community (Pl. viii, figs. 13, 14, 15). Along river banks the canopy extends down to ground level (Pl. viii, fig. 14) and epiphytes which characteristically occupy the higher strata of the forest are found at low levels (Pl. xiii, fig. 58). Lianes, which are light-loving species, are often very abundant along the banks of rivers, forming great masses over the tops of the trees and hanging down almost to the water (Pl. viii, figs. 13, 14).

(2) *Lighter: Trema cannabina, Aneilema biflorum, Colocasia macrorrhiza* (Pl. vii, fig. 9), *Dennstaedtia davallioides* (Pl. vii, fig. 9), *Hypolepis tenuifolia, Hydrocotyle hirta, H. tripartita, Passiflora alba, Panicum lachnophyllum, P. pygmaeum, Pteris incisa, P. tremula, Rubus rosaefolius, Solanum laciniatum,*

Lomandra longifolia, L. Hystrix. (Lianes also occur in this group, but these will be discussed in detail later.)

(3) *Moister but not lighter: Backhousia myrtifolia, Callicoma serratifolia, Eugenia australis, Ficus stephanocarpa, Alsophila Leichhardtiana, Aneilema acuminatum, Diplazium japonicum, Dryopteris parasitica, Athyrium umbrosum, Elatostemma reticulatum* (Pl. viii, figs. 16, 17), *Pteris comans.*

Creeks do not cause a considerable break in the canopy, and the only difference in the flora may be a concentration of water-loving plants such as *Elatostemma* and ferns in the creek bed. *Alsophila Leichhardtiana* not infrequently forms a zone round a damp creek or soakage area (Pl. vii, fig. 2). It also occurs very frequently in the main forest in damp sheltered areas. A number of trees characteristic of river banks, e.g. *Backhousia myrtifolia, Callicoma serratifolia* and *Ficus stephanocarpa,* may be present, forming a creek community, but *Weinmannia rubifolia* is never found, and appears to be an obligate light species.

Areas of forest which were especially shaded showed no significant differences of composition or structure, but some species, e.g. *Blechnum Patersoni,* may be relatively more abundant than elsewhere. Areas which are shaded but dry support a slightly less dense forest, with fewer ferns than the moister areas.

As far as could be seen, no species which grows well in the main forest is unable to grow satisfactorily under conditions of excess moisture and light. There are no significant absences from areas of locally different habitat, such as river banks, of species which are common and widely distributed elsewhere.

(*d*) *Density.*

The number of sample areas is not large enough to generalize for the forest as a whole, but the results confirm the field observations that the density is variable over areas of apparently homogeneous habitat. In Table 5 the density of the vegetation in the quadrat areas is given as number of species per 100 square feet. Shrubs such as *Drimys insipida, Psychotria loniceroides, Eupomatia laurina* and *Wilkiea macrophylla* are given separately from the saplings of tree species. The tree-fern *Alsophila Leichhardtiana, Citriobatus multiflorus* and *Lomandra montana* are also included in the table.

Total vegetation, exclusive of ferns, is on the whole most abundant on the valley floor and lower slopes of the main valley (areas 6, 7, 8, 9, 10). The number of trees higher than 30 feet is also greatest here. Areas 6 and 7 provide exceptions. In area 6, though trees are more numerous than at any other locality investigated, the rest of the vegetation is so scanty that the total is comparatively low. In area 7 the total number of trees is low, but saplings and shrubs are numerous, so that the total is moderately high. With the exception of area 6, in which the density of saplings and shrubs is inversely proportional to the density of trees, no direct relation can be traced between the number of trees, saplings and seedlings or shrubs and ground flora. On the lower valley slopes (areas 3, 5, 11) the vegetation is slightly less dense, and in areas 5 and 11 the trees are fewer than on the main valley floor.

Area 12 shows the density of vegetation in a relatively young piece of rain-forest behind a rapidly advancing margin. The actual structure of the forest is not quite mature and epiphytes are absent, but the percentages of trees, shrubs and saplings fall within the limit of variation of the mature forest.

The lateral gullies show the greatest departure from the valley-floor type. These gullies are mostly very humid and moist, and rather more shaded than the main valley. Tree, shrub and sapling density is lower on the whole, though

the relative proportions of each are similar to those of the flora of the main valley floor. *Alsophila Leichhardtiana* is abundant, reaching its best development on very shaded wet slopes (area 4).

It can be seen that the amount of *Citriobatus multiflorus* is often inversely proportional to the amount of *Alsophila Leichhardtiana*. This can be taken as a measure of the habitat, as *Alsophila* grows in wet shaded areas only and *Citriobatus* prefers the less moist parts of the forest. The density of *Lomandra montana* is fairly evenly low throughout the areas.

The conclusions are supported by field observations which indicate that no very definite relationship can be traced between the density of the flora and its position in the valley. On the whole it appears that the flora is most dense and trees most numerous in the main valley and less numerous in more or less steep-sided tributary-gullies. The canopy of the forest of these lateral gullies is often not significantly less than that of the main valley.

The Rain-Forest Margin.

In any area where two absolutely distinct formations are in contact, it is necessary to determine whether they are stationary with regard to each other, or whether one is encroaching on the other.

If the rain-forest were stationary or retrogressive in relation to the surrounding Eucalypt forest, its margin would be sharply defined, composed of mature but perhaps not large trees; no young rain-forest trees would be present along the margin. A rain-forest which is invading the surrounding Eucalypt forest should show a wide margin of young rain-forest species of gradually decreasing size in the adjacent formation. The width of this zone would therefore be a measure of the relative rate of invasion, but, without detailed investigation over a number of years, no accurate estimate could be given of the actual rate of advance in any area; comparative results only can be given.

A preliminary survey indicated that the rain-forest area is advancing into the Eucalypt-forest area around all its edges with the exception of the uppermost one. The rapidity with which the advance is taking place varies with the aspect and degree of slope. The following types of margin may be distinguished, but it must be remembered that they are only arbitrary divisions of a continuous series.

(*a*) *Slowly-advancing Margins.*

In this type the rain-forest is almost stationary, its edge is very well defined, and the change from Eucalypt forest to rain-forest takes place over a distance of only a few yards (Pl. ix, fig. 18). A few fairly large, old rain-forest trees are present in the adjacent forest and a few young ones may also be present. This type of edge is characteristic of dry or steep exposed slopes and of the lower edge of the forest. It abuts on *Eucalyptus saligna–E. amplifolia* or *E. saligna–E. acmenioides–Casuarina torulosa* forest, with *Casuarina Cunninghamiana* and *Callistemon salignus* in damp places. The commonest species of the rain-forest edge of this type are *Ackama Muelleri* and *Trochocarpa laurina*; both often bear a number of epiphytes. Lianes may be present, in some cases forming a definite community (Pl. x, fig. 29). This condition is never found on rapidly advancing margins.

(*b*) *Intermediate Type of Margins.*

In this type the rain-forest is advancing slowly and steadily. Since the forest immediately surrounding the rain-forest is dominated by *Eucalyptus saligna* and *Syncarpia laurifolia*, the trees of this formation which have been recently engulfed

are not especially conspicuous. The rain-forest edge is marked by some thickets of trees varying in height from 2 feet to 20 feet (a height which in this position could be gained in 2–5 years). Most frequently these thickets are fairly homogeneous over small areas, all consisting of the same species, but at other places several species may be concerned. At this stage they are usually far more closely spaced than in the mature rain-forest, and it is apparent that only a small percentage of them could survive. These thickets are backed by fairly large but not mature trees forming a rain-forest formation of typical structure (Pl. ix, figs. 21, 25). A community which is very common along the edges of these types of margins is a tree-fern one, consisting of *Alsophila australis* (Pl. ix, fig. 20) which is found only in damp sheltered positions around the edges of the rain-forest. It is commonly associated with fairly large trees of *Ackama Muelleri* (Pl. ix, fig. 19). This type of edge is found along the sides and heads of sheltered creeks and on sheltered slopes.

(*c*) *Rapidly-advancing Margins.*

All gradations between this type of margin and the intermediate type can be seen. Fairly numerous young colonists of all kinds, many of them locally forming pure stands, occur along the edges (Pl. ix, fig. 22). Often these extend irregularly into the grassland or Eucalypt forest (Pl. x, fig. 28), whereas the slow and intermediate types show a more or less even front (Pl. ix, fig. 25). Species from the herb and shrub strata of the Eucalypt forest are present amongst the young rain-forest types (Pl. x, fig. 27). This in itself is an indication that the advance is fast, since these species are apparently very light-sensitive and die quickly as the light is decreased. Such a community is not found in the more slowly advancing edges. Behind these pioneer communities are progressively larger trees (Pl. ix, figs. 23, 24), until the mature forest is reached. At a distance from the edge the Eucalypt-forest types are absent and the rain-forest species are not so closely set, indicating that a natural thinning process has occurred. The width of this transition zone between margin and mature forest depends on the rapidity with which the forest is advancing. In some places it is evident that young rain-forest advancing up creek beds has been able to tap a new area suitable for growth, such as a flat part of a spur receiving soakage from steep slopes above (Pl. x, fig. 26). In such regions as this, advance takes place very rapidly. Some advancing margins consist of young trees very closely spaced together (Pl. ix, figs. 23, 24; x, fig. 28). In others the spacing is more open. Open spacing appears to be a characteristic of slightly drier slopes (Pl. x, fig. 27). At first there is no continuous canopy unless the saplings are very closely set. A continuous canopy forms as the forest increases in height.

In the advancing types of margin, lianes are as a rule relatively uncommon in the younger parts and do not assume a leading rôle until the forest has reached a height of about 40 feet. The shrubs, ground flora and epiphytes typical of the mature rain-forest also follow the invasion of trees and are not as a rule found in the younger parts of the margin (Pl. ix, fig. 24). In the younger parts, *Blechnum cartilagineum* and *Dryopteris decomposita* alone of the ground flora occur in any quantity (Pl. ix, fig. 23).

Most of the margins, even if slowly growing or almost stationary, have behind them a zone which is not mature. This immature part constitutes a considerable part of the total rain-forest (Pl. vii, fig. 5). It is impossible to tell, without a study of the annual rings of the component trees, the actual rate of advance, but it is evident that, in the case of the rapidly-advancing margins at least, much Eucalypt forest must have been invaded in historic times.

The advance species of wet rain-forest margins such as occur on a recently-colonized hillside with soakage may differ from those on a dry slope. Those commonly present in wet areas are: *Tristania laurina*, *Eupomatia laurina*, *Ackama Muelleri*, *Hypolepis tenuifolia*, *Histiopteris incisa*, and *Rubus* spp. The chief feature is the relative abundance of ferns (Pl. x, fig. 26). Ferns, on the other hand, do not play a conspicuous part in the colonization of dry slopes, where they are often entirely absent. Common species in dry areas are *Elaeodendron australe*, *Elaeocarpus reticulatus*, *Cryptocarya microneura*, *C. patentinervis*, and *Ackama Muelleri*.

Almost every rain-forest species has been found to occur in the advancing zone, though some species are common while others are rare. Their abundance, as far as could be judged, depends largely on their presence or absence in the adjacent forest, and must also depend greatly on chance, e.g. the production of seeds during a season favourable for their germination and establishment. Amongst the more common rain-forest species which are important in the margins are *Ackama Muelleri*, *Cryptocarya microneura*, *C. patentinervis*, *Elaeocarpus obovatus*, *Rapanea Howittiana*, *Schizomeria ovata*, *Synoum glandulosum*, and *Tristania laurina*. Species which have not been observed in margin communities are *Sloanea australis*, *Emmenospermum alphitonioides*, *Chariessa Moorei*, *Cryptocarya obovata*, *Litsea reticulata*, *Pennantia Cunninghamii*.

(*d*) *True Margin-Communities.*

There are a number of species which are characteristic of the lower rain-forest margin, and are not found commonly elsewhere in the formation. They are found often in moist sheltered places. The most common species are: *Alsophila australis*, *Clerodendron tomentosum*, *Commerconia echinata*, *Croton Verreauxii*, *Hedycarya angustifolia*, *Hibiscus heterophyllus*, *Melothria Cunninghamii*, *Myrtus Beckleri*, *Homalanthus populifolius*, *Sicyos angulata*, *Solanum verbascifolium*, *Trochocarpa laurina*, and *Zieria Smithii*. The composition of this margin flora varies from place to place; any of the above species may be locally dominant over a small area or absent altogether. This margin-community only occurs round the edge of almost stationary rain-forests, especially near creeks. A complete list of species found in this type of locality is given in Table 1, Column 3.

(*e*) *The Upper Margin.*

The main part of the sub-tropical rain-forest occurs in the valleys below 1,500 feet, but deep gullies and soakage areas on the sheltered slopes of hills allow its extension upwards to an altitude of about 3,000 feet. Most of the higher part of the rain-forest is of necessity developed on steep slopes, but occasional flat areas may occur along the upper part of creeks just below the main level of the range, and it is here that the upper part of the sub-tropical rain-forest is best developed.

Above about 1,800 feet the rain-forest is developed on soil derived from basalt, but, as far as could be seen, this was not responsible for any significant floristic change. The structure of the rain-forest remains unchanged (Pl. xi, fig. 38) until near its upper limits, but although the tree, shrub and ground flora strata maintain their relationships, a gradual reduction takes place in the number of species present, as higher altitudes are approached. Such trees as *Baloghia lucida*, *Sideroxylon australe*, and *Sloanea australis* which are common in the lower rain-forest, gradually fade out about 1,500–2,000 feet, *Crytocarya* spp. and *Endiandra* spp. about 2,000–2,500 feet, and then *Daphnandra micrantha* and *Laportea gigas*.

The common tree species of the higher rain-forest are *Dysoxylum Fraserdnum*, *Eugenia Smithii*, *Ackama Muelleri*, *Doryphora sassafras*, *Orites excelsa*, *Tieghemo-*

panax Murrayi, *Schizomeria ovata* and *Eucalyptus obliqua*. Common species of the lower strata are *Dicksonia antarctica*, *Alsophila australis*. *Pteris umbrosa* (Pl. xi, fig. 38), *Adiantum formosum*, *Lomandra montana*, *Elatostemma reticulatum*, *Australina pusilla*, *Pellaea falcata*, *Pleopeltis pustulata*, *Doodia aspera*, *Dryopteris decomposita*, *Arthropteris tenella*, *Histiopteris incisa*, *Citriobatus multiflorus*. *Gymnostachys anceps* and *Rubus parviflorus*. The epiphytic species *Asplenium nidus*, *A. adiantoides* and *Pleopeltis Brownii* frequently occur, and lianes include *Aralia cephalobotrys*, *Cissus antarctica*, *Dioscorea transversa*, *Smilax australis*, *Palmeria scandens* and *Tecoma australis*.

Dicksonia antarctica is abundant in moist and slightly light areas. At the highest altitudes lianes and the tree-top epiphytes become less abundant.

The sub-tropical rain-forest stops entirely just below the winter snow line, at about 3,000 feet. Where it abuts on the Eucalypt forest at its upper margin it appears to be almost stationary, and is not advancing into either the Eucalypt forest or the sub-antarctic rain-forest. The "corkwood" *Ackama Muelleri* forms communities around the margin and is the most common and conspicuous species here. Small gnarled trees of this species, about 20–35 feet high and evidently of considerable age, are present in the adjacent woodland. It appears to be more resistant to cold than most of the sub-tropical rain-forest species. *Alsophila australis* is absent at these high levels. Other species commonly found are *Trochocarpa laurina*, *Astrotricha floccosa*, *Doryphora sassafras*, *Acacia melanoxylon*, *Hymenosporum flavum*, *Tieghemopanax sambucifolius*, *Tristania laurina* (the last three as shrubs 2–6 feet high), *Dicksonia antarctica*, all mostly stunted. Small trees of *Nothofagus Moorei* are also present at about 3,500 feet and above. Mosses and lichens are abundant on tree trunks and rocks in the margin at this level.

Outliers.

The main forest of the Williams River valley does not extend along the river below the altitude of about 1,000 feet. Subsidiary areas of rain-forest which are best termed outliers occur in three types of habitat in the lower valley. The largest areas occur in the valleys of creeks which enter the river below the lower limit of the main rain-forest. In the case of the Williams River the first two creeks below the rain-forest margin have a rain-forest flora extending along their valleys almost to the junction with the main river (Map 1, Part 1; these Proc., 1937, p. 272). Below that the rain-forest outliers become more and more restricted to the upper parts of the creek beds and finally are absent even from these. The outliers furthest from the main rain-forest consist only of a few trees and some lianes. The larger outliers are similar in structure and composition to the main forest.

A feature of the two main outliers of the Williams River valley is the presence of large trees of *Tristania conferta* approaching 120 feet in height and 2 feet 6 inches in diameter in the forest and along the margin. In the main forest only a few trees of this species are present at the lower margin. Other species apparently restricted to the lower outliers are *Pithecolobium pruinosum* and *Tetrastigma nitens*.

Another type of outlier may be termed the "soakage outlier". It is found at the bases of hills sheltered from the west where the tilt of the rocks is such that soakage occurs and drainage collects (Pl. xii, fig. 50). These may be up to an acre in extent or may consist of only a few trees with lianes (Pl. xii, fig. 51). Isolated rain-forest trees, usually of considerable size, occur rarely on sheltered

hillsides or river flats well below the limit of the ordinary outlier. Common species are *Cedrela australis*, *Alphitonia excelsa*, *Cryptocarya glaucescens*, *Duboisia myoporoides*, *Hymenosporum flavum*, and *Pittosporum undulatum*. In most cases the Eucalypt forest which once surrounded these outliers has been cleared so that they now appear in the middle of pasture country. They are mature in structure and few young plants are present. They are probably fairly static, as the surrounding habitats are not suitable for their further development. They are exposed to greater extremes of heat and cold and greater variation in humidity, and receive more light than the trees of the main forest, but have not less available water. In the Williams River valley species in this type of outlier are: (Trees) *Acacia melanoxylon*, *Alphitonia excelsa*, *Codonocarpus attenuatus*, *Commerconia echinata*, *Cryptocarya patentinervis*, *Diploglottis Cunninghamii*, *Ehretia acuminata*, *Eugenia Smithii*, *E. australis*, *Guoia semiglauca*, *Hibiscus heterophyllus*, *Hymenosporum flavum*, *Laportea gigas*, *Scolopia Brownii*, *Trema cannabina*; (Shrubs) *Croton Verreauxii*, *Clerodendron tomentosum*, *Wilkiea macrophylla*, *Notelaea venosa*; (Lianes) *Legnephora Moorei*, *Cudrania javanensis*, *Dioscorea transversa*, *Lonchocarpus Blackii*, *Passiflora alba*, *Arthropteris tenella*, *Sarcopetalum Harveyanum*, *Smilax australis*, *Rubus Moorei*, *Tecoma australis*, and *Cissus antarctica*. Several species occur commonly in these outliers which are not present in the main rain-forest, namely, *Legnephora*, *Codonocarpus*, and *Lonchocarpus*.

A third type of outlier is found along river banks. Isolated rain-forest trees extend along the river for a considerable distance below the margin of the main rain-forest (Pl. xi, fig. 35). Along the Williams River they extend for about 10 miles, becoming gradually fewer and more stunted. A few of the hardier epiphytes and ferns, e.g. *Dendrobium* spp., *Cyclophorus serpens*, and *C. confluens*, are prominent in this type of outlier. *Casuarina Cunninghamiana*, which in the Eucalypt forest forms communities along river banks, is present amongst the colonists, together with *Acacia melanoxylon* and *Angophora subvelutina*. *Casuarina* extends upwards along the river banks for about 1 mile into the main rain-forest.

Regeneration.

The structure described for the rain-forest is based on the mature and, as far as could be ascertained, the undisturbed parts of the forest. Considerable disturbance has taken place in parts of the forest due to timber removal, and this has given opportunities for the study of regeneration.

(*a*) *Regeneration after Slight Destruction.*

Slight destruction is due to the felling and hauling out of one tree, or the natural falling of an old tree overweighted with lianes and epiphytes. As all of the trees of the main stratum are more or less connected with their neighbours by lianes, this results in the bringing down of a mass of lianes and parts of the neighbouring trees. The undergrowth may be broken to some extent, but not destroyed. This results in a greatly increased amount of light reaching the lower strata. Such areas have been termed light breaks. Young trees which are always present in the mature forest, take immediate advantage of the light and grow rapidly. If fresh earth is uncovered by the torn up roots, *Lobelia trigonocaulis*, *Hydrocotyle hirta*, *Galium australe* and other herbs are often amongst the first colonists. The young trees are stimulated to the production of numerous leaves on the lower as well as the upper branches, but tall mature trees remain unchanged.

A light break stimulates an immediate increase in the density and, to a certain extent, in the number of species of ferns of the ground flora (Pl. vii, figs. 7, 9; viii, fig. 12). *Dennstaedtia davallioides*, *Hypolepis tenuifolia* and *Histiopteris incisa* are the most characteristic species, but *Dryopteris decomposita*, *Adiantum* spp., and *Blechnum cartilagineum* are also favoured and, if present before the break took place, increase in luxuriance. In damp places, *Pollia* (Pl. vii, fig. 8), *Colocasia* (Pl. vii, fig. 9), *Aneilema* and *Athyrium umbrosum* may be the chief colonists and may form extensive and almost pure communities. Small lianes (Pl. vii, figs. 6, 9), such as *Rubus* spp., *Melothria Cunninghamii*, *Sicyos angulata*, *Convolvulus marginatus* and *Passiflora alba*, are also found commonly in damp light breaks.

If the break is fairly extensive, *Eucalyptus saligna* usually regenerates in large numbers (Pl. viii, figs. 11, 12), and dense thickets of young saplings are found in old breaks. It is often possible to locate old light breaks by the presence of a fairly large number of Eucalypts in a small area. This species is found in the sapling stage only in light breaks. *Syncarpia laurifolia* rarely regenerates in small light breaks. The rain-forest may therefore regenerate fairly quickly into the mature forest again. Secondary areas such as this do not appear to be more dense than the primary forest, as, with the exception of the *Eucalyptus* seedlings, few new seedlings become established, and the permanent regeneration is due to the growth of the young trees present before the break took place.

If, however, large lianes rooted in the area are brought to ground level by the fall of the tree which supported them, their young growth, backed by a fully developed root-system, is more vigorous and fast growing than any young tree, with the exception of *Eucalyptus*. They are able to root wherever their stems touch the ground, and so spread further afield. Consequently the liane is able to cover young shrubs rapidly and form thickets, often about 10 feet high and quite impenetrable. In some cases the trees may be able to keep pace and raise themselves and their load to the level of the canopy, where, once having obtained their full vigour, their relations with the lianes assume their proper proportion (cf. Pl. vii, fig. 7). In other cases it is evident that the lianes completely smother the vegetation beneath and, by cutting out much light, so weaken it that it remains as a liane community for a long period. The ground flora under such a thicket is very scanty.

(*b*) *Regeneration after Complete Destruction.*

A few areas were found in the rain-forest, mostly near the margin, where disturbance had resulted in total destruction of the flora over an acre or more. Since the ground is mostly very wet, logging and trampling of bullock teams causes it to be cut up easily. After disturbance has ceased in such an area recolonization commences immediately. Tree, shrub and herb members of the forest floor, as well as some weeds introduced during the disturbance, all commence to grow at the same time on an equal footing (Pl. viii, fig. 10). The species commonly found first in these situations are herbaceous, e.g., *Cynoglossum latifolium*, which is able to cover large areas quickly and produces seeds very prolifically, *Lobelia trigonocaulis*, *Galium australe*, *Panicum pygmaeum*, *Hydrocotyle hirta*, *H. tripartita*, *Callitriche verna*, *Solanum* spp. and *Poa caespitosa*. Shrubs and small trees such as *Croton Verreauxii*, *Rhodomyrtus psidioides*, *Duboisia myoporoides*, and *Rubus rosaefolius* are also common. *Eucalyptus* seedlings are usually very abundant and *Syncarpia* seedlings also occur. Liane

seedlings are inconspicuous at this stage. The tallest shrubs occur round the margins of such areas where destruction may not have been so severe (Pl. viii, fig. 10, left side).

No single rain-forest species appears to be particularly favoured by these breaks, a wide variety of species being found mingled with the rain-forest edge species. Communities of large numbers of the same species are rare, but they have been seen in other localities (Pl. x, fig. 33). Colonization may therefore be due to seed-production by a single species at an appropriate time, or to seeds which have lain dormant for years in the soil and have been able to take instant advantage of favourable conditions.

Along the breaks formed by permanent tracks light-loving species are common. *Callitriche verna*, *Croton Verreauxii*, *Rubus rosaefolius*, *Panicum pygmaeum*, *P. lachnophyllum* and various ferns border the track on both sides.

Unused log tracks are colonized by seedlings from the adjacent forest. Pioneer species such as *Callitriche verna* (in holes where water collects), *Lobelia trigonocaulis*, *Solanum* spp., and *Panicum* spp. may precede the permanent flora. When the log tracks pass through mature forest, however, they usually do not cause the formation of a light break and colonization is slow, especially in dry places. Several such tracks were observed, still recognizable though practically unused for 10 years. In the drier parts of the forest such tracks are occupied only by a few ferns and seedlings. In the damp parts, however, they soon become obliterated by thickets of ferns and such herbs as *Pollia crispata*.

The species characteristic of the disturbed areas are: (Shrubs and small trees) *Acronychia laevis*, *Callistemon salignus*, *Croton Verreauxii*, *Duboisia myoporoides*, *Ehretia acuminata*, *Homalanthus populifolius*, *Solanum laciniatum*, *S. pungetium*, *Rubus rosaefolius*; (Lianes) *Melothria Cunninghamii*, *Dioscorea transversa*; (Herbs) *Aneilema acuminatum*, *A. biflorum*, *Acaena sanguisorba*, *Anagallis arvensis*, *Adiantum formosum*, *Callitriche verna*, *Colocasia macrorrhiza*, *Cynoglossum latifolium*, *Geranium molle*, *Hypolepis tenuifolia*, *Hydrocotyle hirta*, *H. tripartita*, *Lobelia trigonocaulis*, *Panicum lachnophyllum*, *P. pygmaeum*, *Pollia crispata*, *Polygonum hydropiper*, *Pteridium aquilinum*, *Pteris tremula*, *Plectranthus parviflorus*, *Oplismenus imbecillus*, *Siegesbeckia orientalis*, *Urtica incisa*, *Viola hederacea*.

(*c*) *Regeneration along the Lower Rain-Forest Margin.*

The lower edge of the rain-forest abuts on a woodland of *Eucalyptus saligna*, *E. amplifolia* and *Callistemon salignus*. In moist places destruction of the rain-forest margin results in the growth of thickets of *Callistemon* (Pl. x, figs. 31, 32), *Eucalyptus* (Pl. x, fig. 30) and *Acacia mollissima*, which appear to be able to regenerate more quickly than the forest species. On the edges of these thickets such species as *Colocasia macrorrhiza* (Pl. x, fig. 32), *Rubus rosaefolius*, *Litsea dealbata*, *Cryptocarya microneura* and the typical rain-forest margin species are present.

Destruction in dry places usually results in the regeneration of rain-forest and Eucalypt-forest species in the same proportion as existed previously. Occasionally thickets of *Acacia* may occur, or dense stands of *Culcita dubia*.

(*d*) *Regeneration of Outliers.*

The regeneration of the *Eucalyptus* spp. is quicker than that of the rain-forest species when abundant material is at hand as a source of seed. If the Eucalypt forest is destroyed for pasture land, no such source of seed is available.

Consequently, if an outlier of rain-forest in a cleared area is partially destroyed, as by fire or clearing, it regenerates to rain-forest again. This can be frequently seen in gully heads or shaded hillsides (Pl. x, fig. 34).

(*e*) *Methods of Regeneration.*

Some species are able to regenerate by means of root suckers, e.g., *Litsea dealbata, Sloanea australis, Cedrela australis* and *Cissus* spp. This ability is possessed only by a few, so that regeneration of a destroyed area of rain-forest is chiefly by seed or from the undestroyed base of the stem.

In the area under investigation, no extensive areas have been denuded by clearing, and the detailed methods of regeneration of the main rain-forest under these conditions are not known.

Special Features.

(*a*) *Epiphytes.*

Epiphytes are indicators of humid atmospheric conditions. The atmosphere of the rain-forest below the canopy is very humid for the greater part of the day and, even at the level of the canopy, dry conditions are never very prolonged. All the rain-forest trees, with the exception of *Eucalyptus saligna*, have rather rough bark which forms an ideal foothold for mosses and lichens.

Large mosses (e.g., *Hypopterigium* sp.) are common on rocks and decaying logs, and extend some distance upwards on the trunks of the trees in gullies or near the river, where humidity is highest. Most of the mature trees, both in gullies and in the main forest, have masses of short mosses (*Macromitrium*, etc.) and foliose lichens as far as the shorter branches (Pl. vii, fig. 2; xiii, figs. 54, 56, 59). Long trailing masses of the moss *Papillaria* are common on the undershrubs and hanging from the lower boughs of the trees (Pl. vii, fig. 8). This mantle of mosses and liverworts does not occur on the trunks of the Eucalypts which decorticate every year (Pl. vii, fig. 3). A considerable growth of the liverwort *Lepidozia* sp. and certain mosses occurs at the extreme base of the trunks (the lowest 2–5 feet), where a dead, fibrous layer of bark persists (Pl. xiii, fig. 55). Epiphytic mosses and liverworts are uncommon on the trunks of *Syncarpia* (Pl. viii, fig. 12).

The epiphytic moss species form a very suitable matrix for the development of epiphytic orchids and ferns (see Table 1). Most of these species are found in the higher levels of the canopy where they obtain most light. Tree species such as *Ackama Muelleri, Dysoxylum Fraseranum, Ehretia acuminata* and *Schizomeria ovata*, are always densely crowded with epiphytes. *Sloanea australis*, which has a relatively much thicker canopy, usually supports a less rich flora, except near the very top. Other than the Bryophytes and lichens, almost all the epiphytes belong either to the ferns or the Orchidaceae, *Peperomia reflexa* (Piperaceae) being a notable exception.

Four classes of epiphytes, exclusive of Bryophytes and lichens, can be distinguished on the basis of their distribution:

(1) Species of very open and exposed situations, e.g., *Cymbidium suave*.—This is not really a rain-forest species and is more common in the Eucalypt forest. It occurs exclusively on *Eucalyptus saligna* in pockets caused by the fall of branches, and above the level of the rain-forest canopy.

(2) Obligate light species, e.g., *Dendrobium speciosum*.—This species is found only on the topmost branches of trees along the river bank, where it gets

maximum light and considerable humidity for part of the day. It extends along the river for a considerable distance below the margin of the rain-forest.

(3) Facultative light species.—This group comprises the majority of the rain-forest epiphytes, e.g., *Dendrobium gracilicaule*, *Asplenium nidus*, *Davallia pyxidata*, *Platycerium bifurcatum*, *Cyclophorus confluens*, *Pleopeltis Brownii*, *Peperomia reflexa* and many others (Pl. xiii, figs. 56, 58). They are found near the top of the canopy, often in masses of considerable size, comprising as many as six different species. Some species, e.g., *Cyclophorus confluens*, are also commonly associated with *Dendrobium speciosum*. Within the rain-forest epiphytes of this class occasionally occur below the canopy in rather shaded places, but their growth is not usually so vigorous as it is higher up (Pl. xiii, fig. 55).

(4) Shade species, e.g., *Bulbophyllum* spp. (frequent), *Sarcochilus* spp., *Trichomanes caudatum*, *Hymenophyllum tunbridgense*, and *Asplenium adiantioides*.—In this section also may be placed the climbing ferns *Arthropteris Beckleri*, *A. tenella* and *Pleopeltis pustulata*, which, though rooted in the ground, send rhizomes up the trunks of trees, to which they cling closely, sometimes attaining a height of 20–30 feet, and invading the stratum of class 3 (Pl. viii, fig. 17, left, and xiii, fig. 60).

With two exceptions, the distribution of the epiphytes appears to be unconnected with the species of tree on which they grow. One of these is *Cymbidium suave*, which grows in decaying branch gaps of *Eucalyptus* spp. The other is *Sarchochilus Hillii*, which is almost invariably found only on *Backhousia myrtifolia*, near streams or rivers; it is likely that the habitat in which it grows, i.e., relatively light, humid localities near water, rather than any actual property of the tree, is responsible for this distribution.

(*b*) *Climbers.*

Lianes are common throughout the forest. Their stems, especially those of species of *Cissus*, form festoons around the larger trees and lie in coils on the floor of the forest (Pl. vii, figs. 1, 7; viii, figs. 15, 16; xiii, figs. 53, 56). They may be grouped either according to their size and relation to the canopy, or according to their climbing mechanism.

On the basis of size they may be grouped in the following manner:

(1) Very large, e.g., *Cissus antarctica*, *C. hypoglauca*, *Lyonsia straminea*, *Palmeria scandens*, *Celastrus australis*, *Piper Novae-Hollandiae*. With the exception of the last species, these lianes develop considerable trunks, up to 6 inches in diameter, and a single plant may cover the canopies of several trees 100 feet or more in height (Pl. viii, figs. 13, 14).

(2) Large, e.g., *Chilocarpus australis*, *Embelia australasica*, *Malaisia tortuosa*, *Morinda jasminoides*, *Tecoma australis*, *Cayratia* sp., *Rhipogonum album* and *Smilax australis*. These species may reach the level of the canopy, but do not spread very far, and do not develop large thick trunks.

(3) Small, e.g., *Aralia cephalobotrys*, *Dioscorea transversa*, *Tylophora barbata* and *Aphanopetalum resinosum*. These rarely reach the canopy of the mature forest, and are most frequent along river banks or other light breaks. In the mature forest they are small and rarely flower.

(4) This class includes climbing species which are typical of the rain-forest margins, and are not found in the mature forest, except rarely in light breaks, e.g., *Sarcopetalum Harveyanum*, *Stephania hernandifolia*, *Sicyos angulata*, *Melothria Cunninghamii*, *Cayratia clematidea* and *Billardiera scandens*.

On the basis of climbing mechanisms the following classes can be distinguished:

(1) Twiners, e.g., *Aralia cephalobotrys*, *Morinda jasminoides*, *Chilocarpus australis*, *Dioscorea transversa*, *Malaisia tortuosa*, *Embelia australasica*, *Tylophora barbata*, *Tecoma australis*, *Billardiera scandens*, *Stephania hernandifolia* and *Sarcopetalum Harveyanum*.

(2) Tendril climbers, e.g., *Cissus* spp., *Cayratia* spp., *Sicyos angulata* and *Melothria Cunninghamii*.

(3) Adventitious root climbers, e.g., *Piper Novae-Hollandiae* and *Lyonsia straminea*.

(4) Stragglers, e.g., *Smilax australis*, *Rhipogonum album*, *Palmeria scandens*, *Celastrus australis* and *Aphanopetalum resinosum*.

Most of these lianes are very weak climbers, and it appears evident that they reach the canopy largely by being carried up by the growth of young trees. During this process large stems are produced which sprawl over the forest floor. This is especially the case with *Palmeria*, *Smilax* and *Rhipogonum*. Only two species (of *Piper* and *Lyonsia*) are able to reach the canopy without assistance in any other way. These species, possessing adventitious roots, can climb straight up the trunk of a large tree. *Lyonsia* is the only liane to be found on *Eucalyptus saligna*. This tree has a smooth bark which is shed every year; thus in order to climb it successfully, a liane must possess strong adventitious roots and a very fast growth rate.

Once the canopy is reached, most lianes sprawl over the tops of the trees, the stems being stiff enough to bridge short intervals. *Piper Novae-Hollandiae* has very weak stems, and characteristically hangs in long trailing masses of several intertwined branches from the tops of trees often nearly to the ground.

(*c*) *Pulvini.*

Pulvini are almost universal amongst the rain-forest trees. They are absent from some of the shrubs. The following species have not been observed to develop pulvini: *Trema cannabina* (Ulmaceae), *Cudrania javanensis* (Moraceae), *Laportea gigas* (Urticaceae), *Hymenosporum flavum* (Pittosporaceae), *Duboisia myoporoides* (Solanaceae), *Clerodendron tomentosum* (Verbenaceae) and *Psychotria loniceroides* (Rubiaceae).

(*d*) *Leaf Characters.*

The leaves of the majority of rain-forest tree species belong to the mesophyll leaf-size class of Raunkiaer (1934). Drip tips are prominent on the leaves of most of the tree species, but the undershrubs show much more variation both in leaf-size and shape. Domatia are a feature of the leaves of some species. Most commonly they occur in the axils of the main and lateral veins, or at the junction of two lateral veins. Those species which invariably show the presence of domatia are *Pennantia Cunninghamii*, *Endiandra Muelleri*, *E. discolor* and *Dysoxylum Fraseranum*.

(*e*) *Seed Characters.*

Seeds produced by the rain-forest trees are for the most part large, especially when compared with those of species characteristic of the Eucalypt forest, and of *Eucalyptus* spp.

(*f*) *Root Systems and Buttresses.*

These observations are based on trees which had fallen, and whose root systems were partially exposed. In all such cases observed the root systems were

very shallow, all the major roots being close to the surface of the ground. Often the major roots can be traced some distance from the tree along the surface of the ground (Pl. xi, fig. 38). This is especially well marked in the case of *Laportea gigas*, whose roots have been traced 20–30 feet from the main trunk.

A very complete description of buttressing in Australian rain-forest trees is given by Francis (1929). The large buttresses described for the northern rain-forests do not occur in the Williams River district, and true buttresses are rare. In the Williams River rain-forest the type of buttress approaches that described by Francis as a flanged stem (Pl. xiii, fig. 54). Here, when well developed, the largest buttresses extend 8–10 feet up the stem and stand out from it several feet, being continuous at the base with the upper sides of roots (Pl. xiii, figs. 53, 60). They are comparatively thick, being much thicker than those of the northern rain-forests. The best developed specimens are found on the following species: *Sloanea australis* (Pl. xiii, fig. 60), *Ackama Muelleri*, *Cryptocarya glaucescens*, *Diploglottis Cunninghamii*, *Doryphora sassafras*, *Dysoxylum Fraseranum* (Pl. xiii, fig. 53), *Pennantia Cunninghamii* and *Schizomeria ovata*. They are usually thick, and extend upwards and outwards to an extent dependent on the size of the tree. The following measurements illustrate this:

Species.	Tree.		Buttresses.		Remarks.
	Height.	Diameter.	Vertical Extent.	Horizontal Extent.	
	Feet.	Feet.	Feet.	Feet.	
Sloanea australis ..	50	1	2½	4	Very thick.
,, ,, ..	60	1¼	2	3	,, ,,
Schizomeria ovata ..	90	5	15	6	,, ,,
,, ,, ..	40	1¼	3	3½	,, ,,

A variation of this is sometimes found, in which the trunk of the tree has several longitudinal furrows, between which it bulges slightly. This structure extends for 6–15 feet up the trunk of the tree, and appears to be restricted to certain species, notably *Diospyros pentamera* (Pl. xiii, fig. 54) and *Doryphora sassafras*. In other cases very small shallow thick buttress-like swellings occur at the very base of the stem, where the main roots emerge.

These phenomena are not found throughout the whole extent of the rain-forest. The best developments of buttresses are always found in the deepest parts of the rain-forest where the soil is permanently very wet and evaporation less at the level of the canopy than elsewhere.

All observations support Petch's (1930) theory that buttresses are the result of a shallow root-system, and lack of a tap root, leading to increased growth of the stem above the point of emergence of the roots.

Allied Rain-Forest Areas.

(*a*) *The Allyn River Valley.*

The rain-forest of the upper Allyn River valley resembles that of the Williams so closely that it can be considered to belong to the same association. The differences that occur are of no greater significance than variations between

different parts of the Williams River forest. Types of margins and upper margin communities are similar in both valleys, and may merge into each other over the Williams Range in places partially sheltered from the west. The upward extent of the rain-forest margin is dependent, as in the Williams valley, on the degree of exposure. On the steep, exposed, westerly-facing slopes of the Williams Range its margin is some 500 feet below the margin on the easterly-facing slope of the valley, but in places where sheltered valleys have been cut by tributary streams, the rain-forest margin is equally high on either side.

The lower part of the valley is more open and exposed than the Williams valley and supports a thinner, more open, younger type of rain-forest. This forest is characterized by a few large trees, between which smaller, younger trees occur. In places the canopy is thin, and a relatively large amount of light gets through to the ground flora. Consequently the ground flora is much more thickly developed than in the mature parts of the forest. Ferns are less important than in the main part of the rain-forest. The most important species of the ground flora are *Gahnia melanocarpa, G. aspera, Gymnostachys anceps, Cyperus appressa, Lomandra montana,* and *Dryopteris decomposita.*

Outliers similar in distribution and structure to those in the Williams valley occur in the Allyn valley. Common species are: *Evodia micrococca, Litsea dealbata, Aphananthe philippinensis, Legnephora Moorei, Cryptocarya glaucescens, Cedrela australis, Mallotus philippinensis, Cudrania javanensis* and *Cissus* spp.

As in the case of the Williams valley, some species occur in the outliers which are not found in the main rain-forest, notably *Legnephora Moorei, Aphananthe philippinensis* and *Mallotus philippinensis. Aphananthe* and *Mallotus* have not been found in the Williams River valley.

A prominent feature of the valley floor below the rain-forest and near the river is the presence of outlier trees of rain-forest species, especially *Cedrela australis.*

(*b*) *The Chichester River Valley.*

The Chichester River valley is wider and more dissected than the Williams, but is fairly well protected from the west. The soil appears to be slightly more sandy than that of the Williams River valley because of the outcropping of granitic rock.

The structure of the mature rain-forest is similar to that of the Williams and Allyn valleys. So far as could be observed, the trees that are common, frequent, sporadic or rare in the Chichester rain-forest are present in much the same proportions as in the Williams valley. The same grouping of species, both of the tree stratum and the shrub and ground flora, is evident. One tree species only, *Sloanea Woollsii,* was collected which has not been observed in the Williams River rain-forest.

The lower part of the Chichester rain-forest is quite distinct from anything found in the Williams valley. It is of a thin type, indicating that it is young, in which respect it resembles the lower Allyn River rain-forest. The canopy is in places thin and even slightly interrupted, grasses, *Gahnia* spp. and *Lomandra* spp., forming the bulk of the ground flora in these breaks, ferns being less common. The individual trees are slightly smaller, and less closely spaced than in the mature rain-forest. The chief point of difference, however, is the presence of *Tristania conferta.* This species occurs throughout the rain-forest here, but is especially abundant near the river, and extends for a short distance into the surrounding Eucalypt forest. It approaches in size *E. saligna* (i.e., about 150 feet high with a

diameter of 4 feet), with which it is associated (Pl. xii, fig. 49). The comparatively open, sunny nature of the lower rain-forest is shown especially by the nature of the river-bank flora, where, in addition to numerous lianes, *Casuarina Cunninghamiana*, *Acacia melanoxylon* and *A. elata* are present. Throughout the lower rain-forest the river bank is occupied by a herb community of *Lomandra longifolia*, *Gleichenia flabellata* and *Blechnum discolor* (Pl. xii, fig. 48). This community does not intrude into the forest for more than a few feet, except in wet, light places, where thickets of *Gleichenia* may be present. It is absent from the banks of the river in the upper dense rain-forest where the river banks are overhung by trees. A list of the species observed in the rain-forest of the Chichester River valley is given in Table 6, column 1.

The structure of the margins is similar to that in the Williams River rain-forest. The following species are common margin constituents: *Callicoma serratifolia*, *Tristania conferta*, *Ackama Muelleri*, and *Trochocarpa laurina*.

Outliers occur, and are similar to those previously described, but are less extensive, as the valley is less sheltered and is largely cleared below the lower margin of the rain-forest. The following species were found in the outliers: *Lonchocarpus Blackii*, *Diploglottis Cunninghamii*, *Legnephora Moorei*, *Glochidion Ferdinandi*, *Alectryon subcinereus*, *Sideroxylon australe*, *Baloghia lucida*, *Guoia semiglauca*, *Myrtus Beckleri*, *Eugenia Smithii* and *Croton Verreauxii*. *Cedrela australis* is an important outlier species in the lower parts of the valley; *Duboisia myoporoides*, *Hymenosporum flavum*, and *Pittosporum undulatum* also occur.

(c) *The Manning River Valley.*

The main rain-forest of the upper Manning River and its tributaries was not investigated. Large outlier patches occur on the north-easterly-facing slopes of the enclosing mountain ranges (Pl. xiv, figs. 5, 6, of Part 1). Observations were made in these and in some isolated areas of rain-forest in sheltered parts of the main valley. These outliers occupy the slopes and beds of the creeks draining the slopes. The crests of the spurs between these creeks are occupied by Eucalypt forest. This type of outlier is illustrated in Plate xiii, fig. 52. Typically they are narrow towards the lower edge, and end where the creek meets the valley floor. They widen out in a fan-shaped fashion round the head of the creek, usually stopping abruptly below the crest of the main range. They are much less frequent and much smaller on the western-facing slopes, where they are present only in the deepest gullies. Small outliers are also present in the valley floor in sheltered and moist areas. Where they are in the undisturbed condition these areas of rain-forest appear to have the same structure as those of the Williams and Allyn River valleys. The general height of the taller trees appears to have been slightly greater than the average in the Williams River valley, approaching 100–120 feet.

A complete list of the rain-forest flora in this district was not made, but the important and conspicuous members of the lower rain-forest outliers are given in Table 6, column 2. *Cedrela australis* appeared to be especially common and in places was regenerating very rapidly after clearing (Pl. x, fig. 33).

Rain-Forest Outliers to the East and West of the Plateau.

Mountainous country continuous with the south-east part of the Barrington Tops Plateau occurs north and east of Dungog. Here deep sheltered gullies occur, but the rainfall is not adequate for the development of a luxuriant rain-forest. Small patches of a type of mixed formation are present here, in which some of the hardier rain-forest species are present. The structure of these outliers is

not so highly integrated as that of a mature rain-forest. Lianes are common, forming thickets, and there is a fairly high proportion of shrub species and Eucalypt-forest species. The canopy of the tree stratum may not be continuous. *Tristania conferta* appears to be the most important single species. Similar outliers occur in the mountains near Gloucester and further east, e.g., at Krambach Mountain (Maiden, 1895).

The rivers which drain the eastern part of the Barrington Tops after leaving their deep valleys flow through undulating hilly country. In this region there appears a typical river-bank flora which, because of its density and floristic composition, is obviously related to the sub-tropical rain-forest (Pl. xi, figs. 35, 36, 37). The chief species are: *Eugenia Ventenatii, Tristania laurina, Cissus* spp., *Cryptocarya glaucescens, Evodia micrococca, Clerodendron tomentosum, Pittosporum undulatum, Guoia semiglauca* and *Eugenia Smithii.*

Small outliers occur to the west of the Barrington Tops Plateau on slopes or sheltered areas where drainage collects. These lack the typical structure of rain-forest and consist of a relatively few tree and liane species. The most common are *Elaeodendron australe, Ficus stephanocarpa, Celastrus australis, Ehretia acuminata, Tecoma australis, Trema cannabina* and *Hymenosporum flavum.* Mixed with them are representatives of the western flora, e.g., *Geijera parvifolia, Canthium oleifolium, Notelaea microcarpa* and *Acacia salicina,* and of the Eucalypt-forest formation in which the outliers occur. The western species have been able to migrate eastwards by way of the Cassilis Geocol.

The Sub-Antarctic Rain-Forest (Beech Forest).

Distribution.

The sub-tropical rain-forest grades into the sub-antarctic rain-forest at 3,000–3,500 feet. The first sign of the change is the occurrence of isolated large trees of *Nothofagus Moorei,* the antarctic beech, amongst the typical species of the upper sub-tropical rain-forest. On sheltered slopes the transition zone is at about 3,500 feet, but on comparatively dry slopes it is 500 feet lower.

The same factor, exposure to the west, which limits the distribution of the sub-tropical rain-forest decides the boundaries of the sub-antarctic rain-forest. On the western side of the Williams Range the upper margin of the forest is 500–700 feet below that on the eastern side, where it approaches the top of the ridge. At or about 4,500 feet, the top of the ridge widens out and flat areas occur which are sheltered by the margin of the plateau from the west. These are occupied by sub-antarctic rain-forest. It extends upwards along beds of creeks and folds in the spurs to the plateau, and is present in a depauperated form along the plateau creeks. The maximum development of the forest takes place at 3,000–4,200 feet, where the trees attain their greatest size. As the upper limit of the forest is approached the heights of the trees decrease.

Composition.

The sub-antarctic rain-forest is essentially similar in composition in the upper Williams, Allyn and Barrington River valleys, and probably also in the valleys of the other rivers draining the plateau. It varies in detail from the lowest levels to the plateau. At the lowest levels there is a certain admixture of sub-tropical rain-forest species, and at the higher levels a number of species are present which are absent from the main part of the forest. In Table 7 a list is given of all the species which have been found forming part of the forest.

Structure.

Nothofagus Moorei is dominant throughout the forest, and, being the only large tree, gives the formation its typical appearance (Pl. xi, figs. 39, 41). This species is evergreen, with small, coriaceous leaves and rough bark, and attains a height of 150 feet and a diameter of 4 feet. It occurs with a frequency of about 2·4 per 100 square feet and appears to be evenly distributed. So conspicuous is it that this type of forest is commonly called beech forest.

Stratification is not so marked in the beech forest as in the sub-tropical rain-forest. The tall-tree layer, consisting of *Nothofagus* with its canopy extending to 150 feet, forms a continuous cover, but does not cut out as much light as the sub-tropical rain-forest trees. The canopy is very deep, the trees producing leafy branches upwards from 30 to 40 feet (Pl. xi, figs. 39, 41, 42). A discontinuous small-tree layer is present, varying in height up to 45 feet. The constituent species are *Doryphora sassafras, Elaeocarpus holopetalus, Quintinia Sieberi, Weinmannia rubifolia* and *Pittosporum undulatum.* Of these, the last three are found only below 4,000 feet. Above this altitude *Atherosperma moschatum* takes their place.

A discontinuous layer of shrubs is present in some places, the individual members of which are somewhat straggling. Important species are *Notelaea venosa, Drimys purpurascens, Citriobatus multiflorus, Hymenanthera dentata, Lomatia arborescens* and *Trochocarpa laurina.* These are most numerous along the margin and some are present in the adjoining Eucalypt forest. It is probable that they are mostly relics of former margins, or Eucalypt forest, as they do not seem to be specially suited to the shaded environment of the rain-forest.

There is a lower stratum of ferns forming a continuous cover in the lighter parts of the forest and especially in very wet areas. The commonest species is the tree-fern *Dicksonia antarctica* (Pl. xi, figs. 39, 40). *Dryopteris acuminata, Asplenium bulbiferum* and *Polystichum aculeatum* are also important. In the drier parts of the forest the ferns are scanty (Pl. xi, figs. 41, 42).

In the sub-tropical rain-forest one of the most conspicuous features is the presence of numerous sapling and seedling representatives of the tree species. This development is entirely lacking in the beech forest; saplings and seedlings are rare except around the margin of the forest.

In Table 8 the results are given of 17 quadrats taken at random in mature sub-antarctic rain-forest at 3,800–4,200 feet. It can be seen from Table 9, which summarizes the results, that the number of trees per unit area is smaller than in the lower forest, but that the relative proportion of large trees is greater.

Lianes are not common in the beech forest and rarely reach the upper levels of the canopy. The most frequently occurring species is *Smilax australis*, which is present at all levels. It is present on trees up to a height of about 60 feet, but more usually forms thorny thickets, which are almost impenetrable, on the lower shrubs and on the ground. Other species are *Streptothamnus Beckleri*, which forms thickets in light places, *Cissus* spp. and *Lyonsia Brownii.* Of these, *Cissus* is only found in the lowest parts of the forest, where it is most protected, and *Lyonsia* and *Streptothamnus* occur at an altitude of 4,000–4,500 feet, but are absent from the lowest parts of the forest.

The number of Angiosperm and Pteridophyte epiphytes, both from the point of view of the number of species and the total number of individuals, is very small compared with that found in the sub-tropical rain-forest. Mosses and lichens are in great abundance both on tree trunks (Pl. xi, fig. 41) and on exposed rock surfaces.

The Margins of the Sub-antarctic Rain-Forest.

The beech forest, like the sub-tropical rain-forest, is invading the adjoining formations on all sides, except where it is in contact with the sub-tropical rain-forest. This invasion is especially marked at the lower levels, where mature Eucalypt trees are frequently present (Pl. xi, fig. 41, left centre) together with the sub-antarctic species. No regeneration of Eucalypts in the beech forest was observed, and all the trees were mature, so that their presence is strong evidence of invasion. Old dead trunks of Eucalypts are also occasionally to be seen still standing in the deeper parts of the forest.

(*a*) *The Margin adjoining the Sub-tropical Rain-Forest.*

Where the lower margin merges into the sub-tropical rain-forest no advance seems to be taking place. The individual trees of *Nothofagus* which are present in the mixed forest are all very large and apparently of considerable age. The transition between the sub-tropical and the sub-antarctic rain-forests takes place in any one area over a vertical range of about 100 feet. Below this is rain-forest of typical sub-tropical structure and above it forest of typical sub-antarctic structure. The lower part of the sub-antarctic forest has, however, a small proportion of species which have obviously come up from lower levels. Chief among these are *Cissus* spp., *Quintinia Sieberi*, *Weinmannia rubifolia*, *Pittosporum undulatum* and *Doryphora sassafras*. All but *Doryphora* are present to an altitude of only 4,000 feet, and are comparatively rare even at lower levels. *Doryphora*, on the other hand, extends to 5,000 feet and is an important member of the forest. The liane *Smilax australis* is of greater importance in the sub-antarctic forest than in the sub-tropical forest.

(*b*) *The Margin adjoining the Eucalypt Forest.*

Where the sub-antarctic forest adjoins the lower Eucalypt forest advance is taking place, and young trees of *Nothofagus* are very common, often forming dense thickets. It is not uncommon to find isolated well-developed young trees in the Eucalypt forest at some distance from the actual margin. A number of shrub and small tree species characteristic of the marginal zone are: *Hymenosporum flavum*, *Hymenanthera dentata*, *Acacia melanoxylon*, *Tristania laurina*, *Hedycarya angustifolia*, *Lomatia arborescens*, *Tieghemopanax sambucifolius* and *Astrotricha floccosa*. *Smilax australis* is common, forming low thickets, and dense communities of the fern *Gleichenia flagellaris* are present in wet places at 3,500–4,000 feet.

The most rapid advance is taking place at 4,000–4,500 feet along flat parts of the ridges at the head-waters of creeks sheltered from the west. Where advance is especially rapid, isolated stands of *Nothofagus* are present in areas of suitable shelter and moisture well in advance of the general forest margin (Pl. xi, fig. 46). These all have the same composition and structure. Beech trees up to 70 feet in height are present in the centre, and around them progressively smaller trees, and finally a marginal zone in which some shrubs characteristic of the surrounding forest are present. The depth of the marginal zone and the number of small trees give a measure of the rapidity with which the forest is advancing. In all cases old Eucalypt trees are present throughout, together with occasional clumps of *Poa caespitosa* and *Lomandra longifolia*.

The margin of the main forest is composed of young trees of *Nothofagus* (Pl. xi, fig. 47), together with a number of characteristic shrubs, the commonest of which are: *Elaeocarpus holopetalus*, *Notelaea venosa*, *Lomatia arborescens*,

Doryphora sassafras, *Tieghemopanax sambucifolius*, *Drimys purpurascens*, *Trochocarpa laurina* and *Hedycarya angustifolia*. *Dicksonia antarctica*, *Polystichum aculeatum* and *Smilax australis* are present also. The tree-fern *Dicksonia* shows a similar relationship to the subantarctic forest as does *Alsophila australis* to the sub-tropical forest (Pl. xi, figs. 44, 45). It is present often with *Polystichum aculeatum* as a definite community around the margins, especially in damp places, but, unlike *Alsophila*, it is also common in the mature rain-forest, apparently because the light is not so greatly diminished as in the sub-tropical rain-forest.

Along the higher margins of the forest, advance is not so rapid. The following species form a true margin community corresponding to that of the lower rain-forest: *Prostanthera lasianthos*, *Leptospermum flavescens*, *Pimelea ligustrina*, and *Tieghemopanax sambucifolius*. *Dicksonia antarctica*, *Trochocarpa laurina* and *Elaeocarpus holopetalus* are usually present in this type of margin also.

(*c*) *The Creek Forest on the Plateau.*

A community comprising some sub-antarctic forest constituents is present along sheltered creeks on the plateau, and is continuous with the main forest into which it grades. The maximum height attained by the trees rarely exceeds 40 feet, and the forest is not very dense. The species usually present are: *Nothofagus Moorei*, *Atherosperma moschatum*, *Elaeocarpus holopetalus*, *Lomatia arborescens*, *Coprosma* spp., *Smilax australis*, *Helichrysum chrysophylla* and *Epacris* spp. Small stunted bushes of *Nothofagus* and *Trochocarpa* along the margins indicate that this community is advancing slowly. Many of the species found in this community are not naturally constituents of the rain-forest. Species of *Coprosma*, *Epacris* and *Helichrysum* form part of the true plateau flora.

Discussion and Conclusions.

Distribution.

Superficially tropical and sub-tropical rain-forests throughout the world have a similar appearance. The chief characteristics are the high, dense canopy, the laurel leaves with drip tips and pulvini, the buttressing of the lower trunks of the trees and, in extreme cases, the presence of prop and stilt roots, the presence of lianes, epiphytes and ferns, and the relatively less abundant shrubs. The numerous epiphytic mosses and lichens indicate a humid atmosphere.

The chief requirements for the development of the forest are a large amount of available moisture and a moderately high temperature. A humid atmosphere due to topographical causes is advantageous, but not absolutely essential, as once the forest is established it controls its own internal atmosphere to a large extent.

Raunkiaer (1934) has emphasized that the distribution of the rainfall is as important as its total amount, and Herbert (1935) has discussed this in relation to the Australian flora. It is evident, for example, that if the greatest amount of rain fell in the winter months and the hot months were dry, a rain-forest could not be supported. The rainfall received by the upper Williams River valley is not greatly in excess of that received by the parts of the Northern Territory described as carrying open forest, but which receive practically their whole rainfall during two or three summer months. In north-eastern New South Wales the rainfall is fairly well distributed, but a rather greater amount is received in the hottest months, so that during this period the atmosphere of the rain-forests is humid, provided that they are protected from the only desiccating wind, the westerly.

On the east coast of New South Wales, where the annual rainfall varies from 3,000–6,000 points, the nature of the soil is a deciding factor in the distribution

of rain-forest, a soil of high water-retaining capacity being essential for its development at this rainfall. The same rainfall which, on the Hawkesbury sandstone near Sydney, is only sufficient to permit the development of Eucalypt forest or scrub, may, on a soil of higher water-retaining capacity, be adequate to support the growth of rain-forest. This control of vegetation by soil type is especially well shown on the Comboyne Plateau, where the average rainfall is 6,500 points p.a. Adjacent siliceous and basalt soils support respectively sclerophyll forest and luxuriant rain-forest. The same type of distribution can be seen at Dorrigo and at Robertson.

The soil derived from all types of rocks present in the area studied appears to be sufficiently good to support the most luxuriant type of vegetation, namely rain-forest, the characters of a good soil being assumed to be high water-retaining capacity, adequate drainage, and an adequate supply of mineral salts and humus. The water-retaining capacity is markedly high in all the soil types examined. As might be expected, soil from the beech forest shows the highest humus content, the lower temperatures prevailing at the altitude at which it occurs being less favourable for the rapid decay and complete destruction of plant remains.

The high and evenly distributed rainfall, combined with a soil of high water-retaining capacity, means that the water supply alone is not a limiting factor in the distribution of communities, except in areas which are especially exposed to evaporation or excessive drainage.

In the area studied, the upper limits of the sub-tropical rain-forest seem to be determined by winter temperature, as it ceases, even in the most favoured localities, at the height at which snow is experienced. The occurrence of frosts may also have a controlling influence at lower altitudes. Frosts do not form beneath the canopies of the lower Eucalypt forest or sub-tropical rain-forest, but they occur in the cleared areas below them. It is probable that the presence of a canopy, by decreasing evaporation, prevents the lowering of the temperature to the necessary extent for frost formation at the lower altitudes, but above 3,000 feet frosts form regularly in winter beneath the canopy of the Eucalypt forest and in the more open parts of the sub-antarctic rain-forest. This must prevent the establishment of seedlings of rain-forest species and consequently the advance of the sub-tropical rain-forest into the Eucalypt forest. A few members of the sub-tropical rain-forest, which are able to withstand a degree of cold, are found in the lower part of the beech forest. It is therefore evident that the beech forest affords more protection than the adjoining Eucalypt-forest formation.

Temperature is probably responsible for the relative poverty of species in the upper parts of the sub-tropical rain-forest. Temperature is also apparently responsible for the few epiphytes other than mosses and lichens to be found in the beech forest, as the conditions of humidity are very favourable.

The west-facing slopes are colonized by rain-forest to a less extent than those sheltered from the west. The question arises therefore whether it is insolation or the effects of the westerly winds which are of importance in determining this effect. Though this would have to be determined by experiment, since in the field no areas were observed which received maximum sunlight and did not also receive considerable wind action, a reduction in the amount of sunlight does not appear to make any significant difference to the composition and structure of the upper layers of the forest, and at most means a slight diminution in the amount of the ground flora. It is therefore probable that the action of the wind

in drying the soil and increasing transpiration is the chief factor controlling the distribution of the rain-forests below 3,000 feet.

Above 3,000 feet the rainfall appears to be such that the soil, even in the Eucalypt forest, is always moist to wet, but even at this altitude the sub-antarctic rain-forest is not developed on west-facing slopes. It appears most likely that this is due to wind action and temperature. Strong snow-laden winds sweep over the edge of the plateau and beat on the west-facing slopes, while the sheltered gullies, though receiving an equal amount of snow, escape the direct action of the wind.

In the area studied in detail, the dip of the rock appears to have no effect on the distribution of the rain-forest. In some places, however, along the lower Gloucester and Manning Rivers rain-forest species occur growing on rather exposed hillsides, and the explanation appears to be that the dip of the rocks causes continual seepage at those points (Pl. xii, fig. 51).

Structure.

The sub-tropical rain-forests of New South Wales resemble in structure those described by Richards (1936) for North Borneo, though they lack their luxuriance. All the important characters noted by Richards, of which the absence of special dominants is the chief, are present. This is in distinction to the Guiana rain-forests described by Davis and Richards (1933), in parts of which dominants definitely occur. They found that the highest type of rain-forest in Guiana developed on the best soil, and that in this forest no special dominants could be detected. On poorer soils, however, a less highly integrated forest with a greater degree of dominance of single species developed. No comparable condition exists in the Williams River valley, where no poor soil types are present.

At Mount Dulit (North Borneo), Richards (1936) found that, of 98 species, each constituted no more than 5% of the total number of plants. Of the 181 trees over 30 feet in height, belonging to 34 different species, which occur in the quadrat areas examined in the Williams River rain-forest, only one species (*Schizomeria ovata*) accounts for more than 10%, and three others (*Doryphora sassafras*, *Ackama Muelleri* and *Cryptocarya glaucescens*) for slightly less. The remaining 30 species each account for 5% or less. Twelve species each occur only once in the areas examined. In the sub-antarctic rain-forest, on the other hand, *Nothofagus Moorei* constitutes 76% of the trees over 30 feet in height.

The Williams River rain-forest is relatively simple when compared with tropical forests, because of the comparatively few species and the rather homogeneous habitat.

In North Borneo, Richards has distinguished two sets of tree species, one mature at 60 feet and another at 25 feet. A rather similar division can be made in the rain-forests of the Williams River. A few species, such as *Diospyros Cargillia*, *Croton Verreauxii* and *Evodia micrococca*, form a class of small trees, rarely attaining a height greater than 30 feet. The remainder attain a height of over 60 feet.

Epiphytes are of great importance in tropical rain-forests throughout the world. Thirty-nine species of epiphytic ferns and phanerogams are present in the sub-tropical rain-forest of the Williams River valley.

In his analysis of the epiphytes of the New Zealand rain-forests, Oliver (1930) found that a large class, to which he referred as "ephemerals", might be either

epiphytic or terrestrial. This "ephemeral" epiphytic class is scarcely represented in the Williams River rain-forest. Only one species, the fern *Hymenophyllum tunbridgense*, which is common on the ground and on rocks, is also found sometimes at low levels on tree trunks. The strangler fig (*Ficus Henneana*) usually starts life as an epiphyte, but very rarely may also behave as a terrestrial species. The climbing ferns such as *Pleopeltis pustulata* and *Arthropteris tenella* are always connected to the earth by long rhizomes, and if these are severed the upper parts die; but Oliver notes that the same species in New Zealand may behave as true epiphytes and have no connection with the ground. Oliver also records *Asplenium bulbiferum* as a true epiphyte, but in the Williams River rain-forest it seems to be exclusively terrestrial. The development of an ephemeral epiphyte class in New Zealand rain-forests is probably due to the greater degree of moisture obtaining there.

Composition and Comparison with other Rain-Forest Areas in New South Wales.

The results obtained from the quadrat analyses are not considered to give a complete picture of the relative abundance of all the species in the sub-tropical rain-forest. Many species which were not recorded at all in the quadrat areas are locally abundant in other parts of the forest which were not analysed in this way. Field observations have shown, however, that the four most important species in the quadrats, *Schizomeria ovata*, *Ackama Muelleri*, *Doryphora sassafras* and *Cryptocarya glaucescens*, are common and relatively abundant throughout the forest, though more numerous in some places than in others. A point brought out to a certain extent is the relative abundance of some species in one area and their absence from another.

Table 2 shows the very high percentage of saplings and seedlings. Many of the saplings may attain a height of 30 feet or more, with a diameter of 2 to 3 inches and a crown of a few dozen leaves. They probably remain in much the same condition for years. Many of them never reach the canopy, and may die even after reaching the 30 feet stage.

The percentage of seedlings belonging to some species is abnormally high, whilst other species common in the tree stratum, e.g. *Schizomeria ovata* and *Doryphora sassafras*, are uncommon as seedlings. This is probably due to the season, some species having flowered and set numerous seeds while others have not flowered at all. This is not unusual in the sub-tropical rain-forest where many species flower very sporadically, while others, notably *Polyosma Cunninghamii*, always seem to have a few flowers present. Table 2 emphasizes the absence of *Eucalyptus* and *Syncarpia* seedlings.

It is a well-known fact that isolated rain-forest trees often flower more freely and regularly than those in the rain-forest, and this is probably related to the greater amount of light which they receive. Many flower in the shrub stage, e.g. *Synoum glandulosum*, *Cryptocarya micronеura*, *C. patentinervis* and *Litsea dealbata*.

It is concluded that the major features of species distribution within the sub-tropical rain-forest are due to chance, i.e. the development of seeds during a good season, and the presence of seedlings able to take advantage of such favourable circumstances as accidental light breaks. All the most important species of trees occur throughout the whole forest, and their local abundance cannot be related to any constant feature of the environment, nor does a group of species occur constantly associated over any type of area. The distribution of individual species appears to be quite independent. This further supports the conclusion

that the distribution is not simply a matter of the environment, for the environment cannot show sufficient changes to account for all the groupings of species which occur. This distribution was born out by the seedlings found. In places one species would be very common, in other places entirely absent, due perhaps to distribution of the seeds by birds or animals.

It follows that the differences between the floras of different and unconnected valleys may be due to the operation of the factor of chance on a larger scale.

A striking feature of the sub-antarctic rain-forest when compared with the sub-tropical rain-forest is the relatively small number of saplings of *Nothofagus Moorei*. The ability to grow under conditions of dense shade appears to be a characteristic of sub-tropical rain-forest species which is not shared by *Nothofagus*.

Interference has been so relatively slight in the rain-forest of the upper Williams River valley that the observations made on regeneration give a picture only of the re-establishment of the complex forest structure directly from existing stock. The sequence of events which follows complete destruction over large areas cannot be traced here. During the early timber-getting operations, the species which suffered most severely was *Cedrela australis*. Very few trees of this species remain, especially in the lower part of the rain-forest, and regeneration does not appear to be going on to any extent. This is noteworthy, as regeneration of cedar is taking place, noticeably in parts of the Allyn, Chichester and Manning River valleys, and is most marked in areas which have been partially cleared. In these parts, where parent trees are present, dense stands of strong growing cedar saplings occur (Pl. x, fig. 33).

It is possible that the relative absence of regeneration of cedar in the Williams River valley may be due as much to the relatively slight amount of disturbance as to the clearing of most parent trees, as the cedar is a prolific producer of winged seeds, which are easily transported by wind. Observations suggest that regeneration of this species is especially favoured by disturbance of the soil and breaks which allow a maximum of light to reach the ground.

Though the largest trees of rosewood (*Dysoxylum Fraseranum*) have been removed, seedlings and saplings of this species are common throughout the forest and are especially abundant in the upper parts of the sub-tropical rain-forest.

Ecological Relationships.

(*a*) *Sub-tropical Rain-Forest.*

Ecologically the sub-tropical rain-forest formation of eastern Australia, to which the Williams River rain-forest belongs, is a homogeneous formation, each species being subordinate to the general structure of the whole. Because of their obvious differences from all other types of flora, the sub-tropical rain-forest and the sub-antarctic rain-forest may each be considered as formations in the sense used by Clements (1916). The amount of variation within the sub-tropical rain-forest is so great that treatment by the conventional methods applied to forest communities is not practicable. It can be seen from a comparison of Tables 2, 3 and 4 that local abundance of an upper stratum species is never linked with a particular type of ground flora, or with a particular group of associated species in the shrub or tree strata.

Until detailed accounts of the structure of the remaining areas of rain-forest in New South Wales and Queensland are available, it would be premature to decide what constitutes an association within this formation, or whether indeed any grouping of rain-forest trees of the order of an association exists. Most of the separate areas of rain-forest in New South Wales are different in details of

composition, and it is possible that the smaller ones may each be considered to belong to the grade of an association. In the larger, more northerly sub-tropical rain-forests a certain amount of variation occurs. Jolly (1928) mentions the importance of the Hoop Pine (*Araucaria Cunninghamii*) in the extreme north of New South Wales and of *Ceratopetalum apetalum* at Dorrigo, where in places it forms nearly pure forests. In Queensland several sub-types of rain-forests are recognized, characterized by different species, and Swain (1928, p. 37) describes a number of regions of rain-forest based on thermal range. This suggests that some rain-forest areas may consist of several associations.

The sub-tropical rain-forests of the Williams River valley may perhaps best be regarded as a mixed association, showing a greater tendency to local abundance of species than was found for a tropical rain-forest in north Borneo by Richards (1936), but much less than was found by Brough, McLuckie and Petrie (1924) for an area of impure sub-tropical rain-forest at Mt. Wilson, N.S.W. It is very probable that a detailed study of a more extensive area of rain-forest which comprises more variety of topography and soil, would yield slightly different results, more especially in the marginal parts of the forest. It is considered, however, that the mixed structure here described is characteristic of the sub-tropical rain-forest of the coast of eastern New South Wales.

The sub-tropical rain-forest of the Williams River district represents a fusion of two formations, of which one, the true sub-tropical rain-forest, has given the character to the whole and determined its ecological position. The subordinate formation is the Eucalypt-forest formation which the rain-forest is still in the process of invading. The little that remains of this consists of the two species *Eucalyptus saligna* and *Syncarpia laurifolia*, which are able to regenerate and maintain themselves independently from, and probably without influencing, the rain-forest. No other important species are common to the Eucalypt-forest formation and the rain-forest.

The variation in composition of the mature forest from place to place appears to be due to chance. Aspect is of minor importance, its influence being shown by the local presence of small communities such as those of water-loving plants in a soakage area, or on a river bank. No true consociation can be recognized. Of the water-loving species the following appear to be able to flourish in the shaded conditions of the mature forest: *Callicoma serratifolia*, *Tristania laurina*, *Laportea gigas* and *Alectryon subcinereus*. *Backhousia myrtifolia* and *Weinmannia rubifolia* are never found in the closed forest and appear to be obligate light species.

Apart from the water- and light-loving communities the only other species which show a selective choice of habitat are the obligate margin species *Trochocarpa laurina*, *Commerconia echinata*, *Hibiscus heterophyllus* and *Solanum stelligerum*.

The sub-tropical rain-forest appears to be fairly highly integrated. If a break occurs in the canopy a great development of ferns takes place. Herbs are not numerous, being scanty in the forest itself. Herbs and shrubs play a large part in the regeneration of partly denuded areas, and these are killed out by lack of light as the break regenerates to mature forest.

(*b*) *Sub-antarctic Rain-Forest.*

Ecologically and floristically the sub-antarctic rain-forest is related to the great system of rain-forests characteristic of the moist, high latitudes of the southern hemisphere, and of high altitudes in the warmer regions. In New South Wales the sub-antarctic rain-forest formation is less continuous and smaller than

the sub-tropical rain-forest, and varies greatly from place to place in floristic composition, though probably no more so than does the sub-tropical rain-forest. Its chief characteristics are the dominance of a few species, the relatively small total number of species when compared with the sub-tropical rain-forest, and the relative paucity of lianes and epiphytic ferns and phanerogams. Mosses and lichens are abundant.

These features mark it off at once from the sub-tropical rain-forest as a different formation, especially in view of the fact that floristically also it is a fairly homogeneous unit.

More work is necessary before it can be determined what associations occur. At present the Williams River sub-antarctic rain-forest is regarded as a distinct association dominated by *Nothofagus Moorei* and *Doryphora sassafras*.

The chief characteristic of the sub-antarctic rain-forest in New South Wales is the importance of the single species *Nothofagus Moorei*. This species does not occur in Victoria or Tasmania, where it is replaced by *Nothofagus Cunninghamii*.

Besides those of the Williams River valley, the only other considerable forests of beech in New South Wales are those of Dorrigo, and the MacPherson Ranges on the Queensland border. The Dorrigo forests have been largely destroyed, but it is evident that in their natural state they did not represent such a pure condition as those of the Williams River valley. They occur on the higher parts of the plateau, but, being further north and the highest altitude being only 3,000 feet, they grow under warmer conditions, and are strongly mixed with sub-tropical species, which seem to have given the forest a tropical rather than a temperate appearance, though many of the typical beech-forest species are present.

The MacPherson Range beech forest described by Herbert (1936) appears to show a condition intermediate between the Dorrigo and Williams River forests. It has the typical appearance of the sub-antarctic forest, but in addition has many species which are intrusive from the sub-tropical forest. It has been reported as advancing over adjacent Eucalypt forest in the same manner as the formation does at Barrington Tops.

Herbert (1935) distinguishes two types of formation in the cold parts of Tasmania, the beech forests which occur in regions of shelter and moisture, and the sub-alpine and alpine vegetation of the exposed areas which is predominantly low. Though a pure sub-alpine flora does not occur on the Barrington Tops Plateau, because the conditions of cold and exposure are not sufficiently extreme, a number of individual sub-alpine species are present. These will be discussed in a later section.

Distribution of Species.

(*a*) *Sub-tropical Rain-Forest.*

The Williams River rain-forest is isolated from the eastern and southern areas of rain-forest by a zone of low rainfall, and from the north by mountain ranges in which discontinuous areas of rain-forest occur. It is therefore to be expected that it will be poorer in species than the northern and eastern rain-forest areas. There is a significant absence from the Williams River valley of many species common in the Manning River rain-forests. The most important are marked * in Table 6.

In the list of the Comboyne flora given by Chisholm (1934 and 1937) 37 species are recorded (see Table 10, column 1) which are not present in the Williams River valley, while only 7 occur in the Williams River valley which are not represented there, including *Polystichum aristatum*, *Malaisia tortuosa*, *Tetrastigma nitens*, *Elaeocarpus obovatus*, *Scolopia Brownii* and *Coelospermum paniculatum*.

At Dorrigo, which is further north than Comboyne, Maiden (1894) has recorded 36 species which have not been found in the Williams River valley, some of which are also absent from Comboyne (see Table 10, column 2).

A number of species recorded by Maiden (1895 and 1898) from Port Macquarie, Krambach and the upper Hastings River (Table 10, columns 3, 4, 5) are not represented in the Williams River valley.

It is apparent, therefore, that temperature probably restricts the distribution of many species occurring on the northern part of the coast. A number of species present along the coast to south of the Hunter River have not been able to migrate westward and colonize the Williams River area. It is probable that the dry zone between the coast and the highlands has formed an effective barrier. Most noticeable of these species are *Livistona australis*, *Archontophoenix Cunninghamiana*, *Flagellaria indica*, *Ceratopetalum apetalum* and *Fieldia australis*.

The most important absence is that of *Ceratopetalum apetalum*, a common member of the rain-forests of Comboyne, Dorrigo, Bulga, the MacPherson Ranges and the south coast. This tree in places forms dense communities, especially in the poorer or marginal part of the forest. It can only be suggested that its absence is due to the distance west of the forest areas and the lack of suitable methods of seed dissemination.

A type of occurrence which may throw some light on the problems of the distribution is shown by *Tristania conferta*, *Aphananthe philippinensis*, *Mallotus philippinensis*, *Legnephora Moorei* and *Lonchocarpus Blackii*. The case of *Tristania conferta* is most outstanding. This species appears to be able to develop only in fairly light situations. In the northern rain-forests of Dorrigo and Bulga it is absent from the densest parts, but is present along some margins, in places forming almost pure stands. It is also present in gullies and on sheltered hillsides from which rain-forest is absent. It is probably not a true rain-forest species, but requires similar conditions of moisture and shelter to those required by rain-forest species. It apparently also requires light for its best development. In the Barrington Tops area it can therefore be regarded as a light-loving species invading the area later than the majority of rain-forest species, and therefore finding little suitable ground for colonization. It is noticeable that in the Williams River valley it is restricted to the lower creeks, where the rain-forest is young, that it is absent from the Allyn valley, and that it is relatively abundant in the Chichester valley. It is apparently absent also from the Manning River, though common near Gloucester and Dungog. This suggests that it has invaded the district by way of outliers to the north-east, and has found more suitable uncolonized ground in the Chichester River valley, having arrived there at an earlier stage of invasion than in the Williams valley. The other species occurring only in the lower outliers of the Williams River valley, i.e. *Mallotus philippinensis*, *Legnephora Moorei* and *Lonchocarpus Blackii*, and in the Allyn valley, *Aphananthe philippinensis*, may similarly be late colonists from other rain-forest areas which are unable to, or have not yet been able to, invade the main forest.

(*b*) *Sub-antarctic Rain-Forest.*

Nothofagus Moorei is here at its southernmost limit, and *Atherosperma moschatum* and *Elaeocarpus holopetalus* at their northernmost limit. *Streptothamnus Beckleri* appears to be a montane rather than a sub-antarctic species; it occurs also at Dorrigo associated with *Nothofagus*.

Although the two rain-forest formations overlap in space, and certain species of the one are present throughout the other, e.g. *Doryphora sassafras*, they are unrelated floristically, ecologically and structurally. In all probability in this area

they were unconnected in the past, the sub-tropical forest occupying the lower floors, and the sub-antarctic forest the upper parts of the valley, and their present contiguity is due to the advance upward of the sub-tropical rain-forest and to a lesser extent downward of the sub-antarctic. For if the upward extent of the sub-tropical rain-forest is finally checked by low temperature, the downward extent of the sub-antarctic forest is probably stopped by high temperature. Whether the beech was present in the original rain-forest of Tertiary times or whether it is a more recent invader following the suitable conditions brought about by the orogenic movements of the late Tertiary cannot here be decided.

The small restricted outliers near Nundle and Moonan Flat may perhaps be regarded as relics of a more extensive forest.

All the isolated areas of rain-forest along the margins of the eastern coast of New South Wales differ in details of composition, but it is probable that they preserve throughout the structure which has been found typical in the Williams River district. It has yet to be determined how much of this variation is due to the factors of the environment, such as water supply, soil, aspect and temperature, and how much is due to chance migration, the inability of a new species to become established in a mature forest, and individual preferences due to soil composition.

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DESCRIPTION OF PLATES VII-XIII.

Plate vii.

1.—Fairly dense sub-tropical rain-forest showing spacing of the trees, relative paucity of the ground flora, and lianes hanging from the trees at the right.

2.—A community of *Alsophila Leichhardtiana* and small ferns on a moist hillside. The tree trunks are those of *Endiandra discolor* and *Gmelina Leichhardtii.*

3.—*Eucalyptus saligna* trees at the lower margin of the sub-tropical rain-forest.

4.—Sub-tropical rain-forest on the south-eastern slope of a hill in the Chichester River valley (1,000 feet altitude) showing *Eucalyptus saligna* trees extending above the level of the rain-forest canopy.

5.—Dense, comparatively young, sub-tropical rain-forest, showing thin tree trunks and lack of undergrowth; an old *Eucalyptus saligna* tree on the left.

6.—A light break in the sub-tropical rain-forest, showing the large number of lianes and ground-flora species present and the canopy extending to a low level.

7.—A light break in dense sub-tropical rain-forest. Note the clumps of *Gahnia* and young shrubs in the foreground and *Syncarpia laurifolia* and *Eucalyptus saligna* trees projecting above the canopy of the rain-forest in the background. Lianes are present on *Syncarpia.*

8.—*Pollia crispata* and ferns in a light break within the sub-tropical rain-forest. The moss *Papillaria* hangs from the branches of the tree at the left.

9.—A light break in the sub-tropical rain-forest, showing the development of liane thickets and communities of *Dennstaedtia davallioides* and *Colocasia macrorrhiza* in moist places.

Plate viii.

10.—Regeneration after removal of the sub-tropical rain-forest cover. Herbs, grasses, ferns and young shrubs become dominant around the margins.

11.—Thickets of young *Eucalyptus saligna* trees regenerating after partial clearing.

12.—Young *Eucalyptus saligna*, ferns and *Gahnia* in a light break in the sub-tropical rain-forest; a *Syncarpia laurifolia* tree occurs on the left.

13.—River bank showing the rain-forest canopy extending to the ground level, with an abundance of lianes completely covering the trees at the left, and *Eucalyptus saligna* extending well above the general level of the canopy.

14.—River bank showing an abundance of lianes covering the trees down to the water level.

15.—Sub-tropical rain-forest along the river at 1,000 feet altitude, showing the development of *Dicksonia antarctica* and *Lomandra Hystrix* in open, light areas.

16.—A small creek through dense sub-tropical rain-forest, showing scanty development of ground flora, mostly ferns.

17.—A small creek through dense sub-tropical rain-forest, showing the scanty development of ground flora owing to the unbroken canopy overhead. Fairly dense patches of tall shrubs occur, and *Elatostemma reticulatum* and a dense covering of moss on a fallen log are present on the left.

Plate ix.

18.—A relatively static sub-tropical rain-forest margin along a gully in a northerly-facing hillside. Tall *Eucalyptus saligna* trees can be seen towering above the level of the rain-forest in the creek. *Alsophila australis* and *Ackama Muelleri* are present in the rain-forest margin. *Eucalyptus saligna–Syncarpia laurifolia* forest with *Poa, Lomandra* and *Pteridium* occurs outside the rain-forest.

19.—A community of *Alsophila australis* in a damp, sheltered part of the *Eucalyptus saligna* forest. A pioneer tree of *Ackama Muelleri* from the rain-forest can be seen in the background.

20.—Margin of the sub-tropical rain-forest, fringing a creek on a north-easterly facing slope of the Williams Range (at 1,700 feet altitude), in contact with the *Eucalyptus acmenioides–E. campanulata* forest with *Imperata, Poa, Lomandra* and *Pteridium.* A border community of *Alsophila australis* and *E. saligna* occurs in the rain-forest margin.

21.—A typical, lower sub-tropical rain-forest showing some established trees about 25-30 feet high (*Rhodamnia trinervia* in the centre front), and young trees 1-2 feet high (about 1,000 feet altitude).

22.—A dense community of *Acronychia laevis* and *Rhodomyrtus psidioides* invading *Eucalyptus saligna* forest in the valley floor (about 1,000 feet altitude).

23.—Advancing margin of the sub-tropical rain-forest showing dense thickets of young *Schizomeria ovata* and *Callicoma serratifolia* trees, with *Dryopteris decomposita* forming the ground flora.

24.—A fairly dense community of saplings of *Daphnandra micrantha* and *Cryptocarya patentinervis* intrusive into the *Eucalyptus saligna* forest (note the large tree of *E. saligna* in the background), showing sparsity of the ground flora.

25.—Sub-tropical rain-forest margin advancing into the *Eucalyptus saligna* forest.

Plate x.

26.—Young rain-forest species and well-established trees of *Ackama Muelleri* colonizing a sheltered slope occupied by *Eucalyptus campanulata* and *E. saligna* forest, with a ground flora of *Culcita dubia*.

27.—*Eucalyptus campanulata–Casuarina torulosa* forest in process of invasion by rain-forest species (visible in the background and at right), with ground flora of *Lomandra longifolia*.

28.—A sub-tropical rain-forest margin, consisting of a thicket of *Callicoma serratifolia* with a tall tree of *Ackama Muelleri* on the left, advancing into the *Syncarpia laurifolia–Tristania conferta* forest; ground flora consists of *Imperata, Pteridium* and *Hibbertia* (Chichester River valley); *Syncarpia* and *Tristania* trees can be seen on the right.

29.—A sub-tropical rain-forest margin, showing heavy development of liane species, in contact with *Syncarpia laurifolia–Eucalyptus saligna* forest with some *Casuarina torulosa*; ground flora of *Imperata, Pteridium* and *Poa*.

30.—*Eucalyptus saligna* regenerating along the lower cleared margin of the sub-tropical rain-forest.

31.—A thicket of *Callistemon salignus* trees outside the lower limit of the sub-tropical rain-forest.

32.—*Colocasia macrorrhiza* and *Callistemon salignus* regenerating in cleared wet areas outside the limit of the rain-forest.

33.—Dense thicket of *Cedrela australis* regenerating in partly cleared rain-forest (Manning River valley, Coneac district).

34.—Regeneration of sub-tropical rain-forest in a gully in a cleared hillside facing south-west (Manning River valley).

Plate xi.

35.—Lianes and rain-forest trees along the river bank, with *Eucalyptus saligna* forest in the background (Chichester River valley).

36.—Outlier trees of *Eugenia Ventenatii, Cryptocarya glaucescens* and *Cedrela australis* along a river bank near Dungog.

37.—Communities of sub-tropical rain-forest trees fringing the Karuah River near Stroud, in pasture country.

38.—A typical, mixed sub-tropical rain-forest community at an altitude of about 3,200 feet on the Williams Range. The tree in the centre front is *Orites excelsa*, and *Pteris umbrosa* is conspicuous in the ground flora at the left; note also the shallow tree-roots in the centre foreground.

39.—The sub-antarctic rain-forest at an altitude of about 3,800 to 4,000 feet, showing *Nothofagus Moorei* and *Dicksonia antarctica*.

40.—A stand of *Dicksonia antarctica* in the *Nothofagus Moorei* (antarctic beech) forest, at an altitude of about 4,000 to 4,500 feet.

41.—A relatively mature *Nothofagus Moorei* forest at an altitude of about 4,200 feet, showing the low canopy extending almost to the ground, and the absence of a ground flora except for a few ferns. A tree of *Eucalyptus fastigata* can be seen in the background on the left.

42.—A comparatively young *Nothofagus Moorei* forest showing the deep canopy, the absence or sparsity of the ground flora, and the accumulation of litter.

43.—Beech forest intrusive into Eucalypt forest. *Eucalyptus viminalis* can be seen on the right and in the background, with young *Nothofagus Moorei, Poa* and *Lomandra* in the foreground. Note the litter accumulated under the *E. viminalis* trees. (Altitude about 4,000 feet.)

Plate xii.

44.—Young beech-forest occupying the head of a sheltered creek facing north-east on the Williams Range, at an altitude of 3,900 feet, showing the tree-fern *Dicksonia antarctica* partly enclosed by the *Nothofagus Moorei* community. The foreground and left show the *Eucalyptus obliqua–E. viminalis* forest, with a ground flora of *Poa, Lomandra* and *Senecio*.

45.—Margin of a beech forest occupying a moist area in the sheltered head of a gully on the western side of the Williams Range, at an altitude of about 3,900 feet. In the background can be seen young *Nothofagus Moorei* trees, with *Alsophila australis* and *Dicksonia antarctica*, and in the foreground *Eucalyptus obliqua* and *E. viminalis*. Note the dense ground cover of *Poa* and *Lomandra* in the Eucalypt forest, the steepness of the slope, and the masses of *Macromitrium* on dead flakes of bark of *E. viminalis*.

46.—Beech forest intrusive into *Eucalyptus pauciflora–E. fastigata* forest at 4,800 feet (*E. pauciflora* centre, *E. fastigata* left). Ground flora of *Poa, Lomandra, Pteridium*, and a small plant of *Lomatia arborescens* in the right foreground.

47.—Young *Nothofagus Moorei* advancing into *Eucalyptus pauciflora* forest at 4,800 feet.

48.—River-bank community of *Gleichenia flabellata, Blechnum discolor* and *Lomandra longifolia* (Chichester River valley).

49.—*Tristania conferta* trees (about 160 feet high) occurring in rather open rain-forest (Chichester River).

50.—Outliers of sub-tropical rain-forest species growing in a soakage area at the base of a hill (Williams River valley, altitude about 900 feet).

51.—Outlier species (lianes and *Daphnandra micrantha*) occurring in a soakage area on hillsides in partly cleared Eucalypt forest (Manning River valley, near Coneac).

Plate xiii.

52.—Sub-tropical rain-forest occurring in a gully on a north-easterly-facing hillside in the Manning River valley near Coneac. This photograph shows the spreading of the upper margin of the rain-forest and its abrupt cessation just below the top of the hill.

53.—*Dysoxylum Fraseranum* showing the buttressing of the lower part of the trunk. Note the typical thin trunk of *Alsophila Leichhardtiana* in the foreground, and the stems of some lianes lying horizontally at the base of the tree.

54.—*Diospyros pentamera* in dense rain-forest, showing the shallow nature of the root system and the furrowing of the trunk between the roots.

55.—*Eucalyptus saligna* in rain-forest, showing development of Bryophyte colonies on the base of the trunk. Numerous lianes and the epiphytic bird's-nest fern (*Asplenium nidus*) can be seen.

56.—Typical sub-tropical rain-forest showing the shrub stratum, including *Citriobatus multiflorus* and *Psychotria loniceroides*, numerous lianes, and some epiphytic ferns such as *Asplenium nidus* and *Pleopeltis Brownii*.

57.—*Dawsonia superba* occurring on a shaded bank, illustrative of the dense carpets sometimes formed by the moss constituents of the ground flora.

58.—A tree trunk heavily covered with epiphytes, chiefly *Pleopeltis Brownii*, also young *Asplenium nidus* and orchids.

59.—*Ficus Henneana* showing aerial roots enveloping the "host" tree and the development of incipient buttresses.

60.—*Sloanea australis* showing slight buttressing of the lower part of the trunk.

TABLE 1.

List of Species occurring in the Sub-Tropical Rain-Forest and Rain-Forest Margins of the Williams River Valley.

Life Forms classed according to Raunkiaer (1934). R, rare; S, scanty; F, frequent; LC, locally common; C, common; VC, very common; LVC, locally very common.

Species.	Life-form.	Main Rain-forest.	Rain-forest Margin.	Species.	Life-form.	Main Rain-forest.	Rain-forest Margin.
Pteridophyta.				Polypodiaceae.			
Hymenophyllaceae.				*Adiantum aethiopicum* L. ..	H		S
Hymenophyllum tunbridgense Sm.	Ch	LC		*affine* Willd.	H	C	
Trichomanes caudatum Brack.	E	S		*diaphanum* Bl.	H	LC	R
Cyatheaceae.				*formosum* R.Br.	H	C	
Alsophila australis R.Br. ..	N		LC	*hispidulum* Sw.	H	C	
Leichhardtiana F.v.M. ..	M	LC		*Arthropteris Beckleri* Mett. ..	N	LC	
Dicksonia antarctica Labill. ..	N		R	*tenella* J.Sm.	N	C	

TABLE 1.—*Continued.*

Species.	Life-form.	Main Rain-forest.	Rain-forest Margin.
Asplenium adiantoides C.Chr.	E	C	
bulbiferum Forst.	H	LC	
nidus L.	E	C	
Athyrium umbrosum Presl. ..	H	LC	
Blechnum capense Schlecht. ..	H	LC	
cartilagineum Sw.	H-Ch	C	
Patersoni Mett.	H	LC	
Culcita dubia Maxon	H		VC
Cyclophorus confluens C.Chr. ..	E	C	
serpens C.Chr.	E	C	LC
Davallia pyxidata Cav. ..	E	C	
Dennstaedtia davallioides Moore	H	LC	
Diplazium japonicum Beddome	H	LC	LC
Doodia aspera R.Br.	H-Ch	LC	
caudata R.Br.	H-Ch		R
Dryopteris acuminata Watts ..	H-Ch	LC	LC
decomposita O. Kuntze ..	H	VC	
parasitica O. Kuntze ..	H	S	
Histiopteris incisa J.Sm. ..	H	LC	
Hypolepis punctata Mett. ..	H		LC
tenuifolia Bernh.	H	LC	LC
Pellaea falcata Fée	H	C	
Platycerium bifurcatum C.Chr.	E	VC	
Pleopeltis Brownii Fourn. ..	E	C	
diversifolia Melvaine ..	N	R	
pustulata Moore	N	C	
Polypodium Billardieri C.Chr.	H	R	
Polystichum aculeatum Schott.	H	F	
aristatum Presl.	H	R	
Pteris comans Forst.	H	R	
tremula R.Br.	H	S	
umbrosa R.Br.	H	LC	
Angiosperms.			
Monocotyledons.			
Gramineae.			
Microlaena stipoides R.Br. ..	H-Ch		F
Oplismenus aemulus Kunth. ..	Ch		R
imbecillus Kunth.	Ch		F
Panicum lachnophyllum R.Br.	Ch		R
pygmaeum R.Br.	Ch		LC
Poa caespitosa G.Forst. ..	H		C
Pollinia nuda Trin.	Ch		LC
Cyperaceae.			
Carex appressa R.Br.	H	S	
longifolia R.Br.	H	S	LC
Cyperus difformis L.	H	S	R
tetraphyllus R.Br.	H	S	
Gahnia aspera Spreng.	H	S	LC
melanocarpa R.Br.	H	S	LC
Lepidosperma laterale R.Br. ..	H	S	S
Araceae.			
Colocasia macrorrhiza Schott.	Ch	LC	LC
Gymnostachys anceps R.Br. ..	H	LC	S
Commelinaceae.			
Aneilema acuminatum R.Br. ..	Ch	S	F
biflorum R.Br.	Ch	R	R
Pollia crispata Benth. ..	H	LC	LC
Juncaceae.			
Juncus pauciflorus R.Br. ..	H	S	F
Liliaceae.			
Eustrephus latifolius R.Br. ..	M		S
Geitonoplesium cymosum A.Cunn.	M		S
Lomandra Hystrix Fraser & Vickery	H	S	
longifolia Labill.	H		F
montana Fraser & Vickery ..	H	C	
Rhipogonum album R.Br. ..	M	LC	
Smilax australis R.Br.	M	F	
Dioscoreaceae.			
Dioscorea transversa R.Br. ..	M	S	F
Orchidaceae.			
Bulbophyllum exiguum F.v.M.	E	C	
Shepherdi F.v.M.	E	C	
Calanthe veratrifolia R.Br. ..	H	LC	
Corysanthes pruinosa A.Cunn.	G		R
Cymbidium suave R.Br. ..	E	F	
Dendrobium aemulum R.Br. ..	E	R	
Beckleri F.v.M.	E	S	
gracilicaule F.v.M.	E	VC	
pugioniforme A.Cunn. ..	E	LC	
speciosum Smith	E	LC	
tenuissimum Rupp	E	R	
teretifolium R.Br.	E	C	
Pterostylis concinna R.Br. ..	G		F
grandiflora R.Br.	G		F
longifolia R.Br.	G		F
nutans R.Br.	G		F
Sarcochilus falcatus R.Br. ..	E	F	
Hillii F.v.M.	E	LC	
olivaceus Lindl.	E	LC	
spathulatus Rogers	E	R	
Spiranthes australis Lindl. ..	G		R
Dicotyledons.			
Casuarineae.			
Casuarina Cunninghamiana Miq.	MM		LC
Piperaceae.			
Peperomia reflexa A.Dietr. ..	E	F	
Piper Novae-Hollandiae Miq.	MM	F	
Ulmaceae.			
Trema cannabina Lour. ..	M	S	F
Moraceae.			
Cudrania javanensis Trée. ..	M	R	S
Ficus Henneana Miq. ..	MM	F	
stephanocarpa Warb. ..	MM	LC	
Malaisia tortuosa Blanco ..	M	F	
Urticaceae.			
Elatostemma reticulatum Wedd.	Ch	LC	LC
Laportea gigas Wedd.	MM	LC	
Urtica incisa Poir.	Ch		S
Proteaceae.			
Lomatia arborescens Fraser & Vickery	MM	LC	
Orites excelsa R.Br.	MM	C	
Stenocarpus salignus R.Br. ..	MM	LC	

TABLE 1.—*Continued.*

Species.	Life-form.	Main Rain-forest.	Rain-forest Margin.
Loranthaceae.			
Loranthus alyxifolius F.v.M. ..	E	S	
dictyophlebus F.v.M. ..	E	F	
Caryophyllaceae.			
Stellaria flaccida Hook. ..	Ch		LC
Ranunculaceae.			
Clematis aristata R.Br. ..	M		S
glycinoides DC.	M		S
Menispermaceae.			
Sarcopetalum Harveyanum F.v.M.	M	F	F
Stephania hernandifolia Walp.	M	F	F
Anonaceae.			
Eupomatia laurina R.Br. ..	M	C	
Monimiaceae.			
Daphnandra micrantha Benth.	MM	LC	
Doryphora sassafras Endl. ..	MM	VC	
Hedycarya angustifolia A.Cunn.	M		R
Palmeria scandens F.v.M. ..	MM	VC	
Wilkiea macrophylla A. DC. ..	M	LC	
Winteraceae.			
Drimys insipida Druce ..	M	VC	
Lauraceae.			
Cryptocarya erythroxylon Maiden & Betche	MM	F	
glaucescens R.Br.	MM	C	
microneura Meissn.	MM	C	
obovata R.Br.	MM	LC	
patentinervis F.v.M. ..	MM	C	
Endiandra discolor Benth. ..	MM	F	
Muelleri Meissn.	MM	S	
Litsea dealbata Nees	MM	LC	
reticulata Benth.	MM	LC	
Saxifragaceae.			
Abrophyllum ornans Hook. f.	M	R	R
Polyosma Cunninghamii J.J. Benn.	MM	VC	
Quintinia Sieberi A. DC. ..	MM	S	
Pittosporaceae.			
Billardiera scandens A.Cunn. ..	M		F
Citriobatus multiflorus A.Cunn.	N	VC	
Hymenosporum flavum F.v.M.	MM	S	
Pittosporum revolutum Ait. ..	MM	S	
undulatum Andr.	M	S	S
Cunoniaceae.			
Ackama Muelleri Benth. ..	MM	C	LC
Aphanopetalum resinosum Endl.	M	S	S
Callicoma serratifolia Andr. ..	MM	LC	LC
Schizomeria ovata D.Don. ..	MM	VC	
Weinmannia rubifolia Benth...	M	S	LC
Rosaceae.			
Acaena sanguisorba Vahl. ..	Ch		LC
Rubus moluccanus L.	MM	LC	
Moorei F.v.M.	MM	S	
rosaefolius Sm.	N	LC	LC
Leguminosae.			
Acacia elata A.Cunn.	MM		R
melanoxylon R.Br. ..	MM	S	F
mollissima Willd.	M		LC
Desmodium varians Endl. ..	Ch		S
Pithecolobium pruinosum Benth.	MM	R	
Rutaceae.			
Acronychia laevis R. & G.Forst.	MM	F	F
Evodia micrococca F.v.M. var. *pubescens* Fraser & Vickery	M	LC	S
Pleiococca Wilcoxiana F.v.M.	MM	R	
Zieria Smithii Andr.	N		F
Meliaceae.			
Cedrela australis F.v.M. ..	MM	F	
Dysoxylum Frascranum Benth.	MM	LC	
Synoum glandulosum A.Juss. ..	MM	C	
Euphorbiaceae.			
Baloghia lucida Endl.	MM	C & LVC	
Breynia oblongifolia J.Muell. ..	M	S	F
Claoxylon australe Baill. ..	M	F	
Croton Verreauxii Baill. ..	M	LC	F
Glochidion Ferdinandi J.Muell.	MM	F	F
Homalanthus populifolius Grah.	M		F
Anacardiaceae.			
Rhodosphaera rhodanthema Engl.	MM	S	
Celastraceae.			
Celastrus australis Harv. & F.v.M.	MM	S	
Cunninghamii F.v.M. ..	N		S
Elaeodendron australe Vent. ..	MM	S	
Icacinaceae.			
Chariessa Moorei Engl. ..	MM	S	
Pennantia Cunninghamii Miers	MM	LC	
Sapindaceae.			
Alectryon subcinereus Radlk...	MM	LC	
Arytera foveolata Radlk. ..	M	LC	
Diploglottis Cunninghamii Hook.f.	MM	LC	
Dodonaea megazyga F.v.M. ..	M		LC
Guoia semiglauca Radlk. ..	MM	LC	
Rhamnaceae.			
Alphitonia excelsa Reiss. ..	MM	S	
Emmenospermum alphitonioides F.v.M.	MM	R	
Vitaceae.			
Cayratia clematidea Domin ..	M	S	F
sp.	MM	R	
Cissus antarctica Vent. ..	MM	VC	
hypoglauca A.Gray	MM	VC	
Tetrastigma nitens Planch. ..	MM	R	
Elaeocarpaceae.			
Elaeocarpus obovatus G.Don ..	MM	F	
reticulatus Sm.	MM	F	
Sloanea australis F.v.M. ..	MM	C	

TABLE 1.—*Continued.*

Species.	Life-form.	Main Rain-forest.	Rain-forest Margin.
Malvaceae.			
Hibiscus heterophyllus Vent. ..	M		F
Howittea trilocularis F.v.M. ..	M		S
Sterculiaceae.			
Brachychiton acerifolius F.v.M.	MM	F	
Commerconia echinata R. & G.Forst.	M		LC
Flacourtiaceae.			
Scolopia Brownii F.v.M. ..	M	F	S
Passifloraceae.			
Passiflora alba Link & Otto ..	M		S
Thymelaeaceae.			
Pimelea ligustrina Labill. ..	N		S
Myrtaceae.			
Backhousia myrtifolia Hook. & Harv.	MM	LC	LC
Callistemon salignus DC. ..	MM	R	LC
Eugenia australis Wendl. ..	MM	F	S
Smithii Poir.	MM	LC	S
Eucalyptus saligna Sm. ..	MM	LC	F
Wilkinsoniana R.T.B. ..	MM		S
Myrtus Beckleri F.v.M. ..	N	S	F
Rhodamnia trinervia Blume ..	MM	F	F
Rhodomyrtus psidioides Benth.	M	LC	F
Syncarpia laurifolia Ten. ..	MM	F	
var. *glabra* Benth. ..	MM	R	
Tristania conferta R.Br. ..	MM	S	LC
laurina R.Br.	MM	F	F
Araliaceae.			
Aralia cephalobotrys Harms. ..	M	F	
Astrotricha floccosa DC. ..	M		S
Tieghemopanax elegans R.Viguier	MM	F	
Murrayi R.Viguier ..	MM	F	
sambucifolius R.Viguier ..	M	F	F
Umbelliferae.			
Hydrocotyle hirta R.Br. ..	Ch	S	LC
tripartita R.Br.	Ch-H		LC
Epacridaceae.			
Leucopogon juniperinus R.Br.	N		R
Trochocarpa laurina R.Br. ..	M	LC	C
Myrsinaceae.			
Embelia australasica Mez. ..	M	F	
Rapanea Howittiana Mez. ..	M	R	S
variabilis Mez.	M		S
Sapotaceae.			
Sideroxylon australe Benth. ..	MM	LC	
Ebenaceae.			
Diospyros Cargillia F.v.M. ..	M	LC	F
pentamera F.v.M.	MM	LC	

Species.	Life-form.	Main Rain-forest.	Rain-forest Margin.
Styraceae.			
Symplocos Thwaitsii F.v.M. ..	MM	R	
Apocynaceae.			
Chilocarpus australis R. & G.Forst.	MM	S	
Lyonsia straminea R.Br. ..	MM	C	
Parsonsia velutina R.Br. ..	MM	R	
Asclepiadaceae.			
Tylophora barbata R.Br. ..	M	R	
paniculata R.Br.	M	R	
Convolvulaceae.			
Convolvulus marginatus Poir.	M		R
Boraginaceae.			
Cynoglossum latifolium Poir. ..	Th	R	C
Ehretia acuminata R.Br. ..	MM	F	
Verbenaceae.			
Clerodendron tomentosum R.Br.	M	S	S
Gmelina Leichhardtii F.v.M. ..	MM	R	
Labiatae.			
Plectranthus parviflorus Henck.	Ch	S	F
Solanaceae.			
Duboisia myoporoides R.Br. ..	M	S	F
Solanum laciniatum Ait. ..	M		F
pungetium R.Br.	N		S
stelligerum Sm.	N		F
verbascifolium L.	M		S
Scrophulariaceae.			
Gratiola pedunculata R.Br. ..	H		S
peruviana L.	H		S
Bignoniaceae.			
Tecoma australis R.Br. ..	MM	S	S
Rubiaceae.			
Coelospermum paniculatum F.v.M.	MM	R	
Galium australe DC.	Ch	R	S
umbrosum Sol.	Ch	R	S
Morinda jasminoides A.Cunn.	MM	LC	
Psychotria loniceroides Sieb. ..	M	LC	
Caprifoliaceae.			
Sambucus australasica Fritsch	M	R	
Cucurbitaceae.			
Sicyos angulata L.	M		S
Melothria Cunninghamii Benth.	M		S
Campanulaceae.			
Lobelia trigonocaulis F.v.M. ..	Th	LC	
pedunculata R.Br.	Ch		S
Compositae.			
Helichrysum Beckleri F.v.M. ..	M	R	
Vittadinia australis A.Rich. var. *tenuissima* Benth. ..	N	R	

TABLES 2, 3, 4, 5.

Numbers of species per quadrat are given in three classes: above 30 feet, between 3 and 30 feet, below 3 feet.

The quadrat areas were located as follows: 1.—Lateral gully, 26 quadrats; 2.—Lateral gully, 8 quadrats; 3.—Lower slope of hillside, main valley, 5 quadrats; 4.—Dry slope of hillside, lateral gully, 5 quadrats; 5.—Lower slope of hillside, main valley, 12 quadrats; 6.—Valley floor, 9 quadrats, 7.—Valley floor, 7 quadrats; 8.—Valley floor, 12 quadrats; 9.—Valley floor, 14 quadrats; 10.—Valley floor, 16 quadrats; 11.—Lower slope of hillside, main valley, 22 quadrats; 12.—Upper slope of hillside, main valley in advancing margin zone, 16 quadrats.

TABLE 2.

Numbers of Trees and Shrubs in quadrat areas.

Quadrat Area Numbers.	1			2			3			4			5			6			7			8			9			10			11			12			Total.		
Heights.	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′	>30′	3-30′	<3′
Acacia melanoxylon																1																				1		
Achama Muelleri	8	1	1	3	1	11	1						3		2				1	2	2 4	3	1		9			6	3			3	7	3	8	13	37	19	36 4
Acronychia laevis								1								1	1			2			2			2			5	8					1		1	14	8
Alectryon subcinereus																				1									4						5	1		10	4
Arytera foveolata									3													10	8									1					11	9	
Backhousia myrtifolia				1	1											3	1								.3	2			3	6	5	3		1	1	1	18	15	7
Baloghia lucida							6	4									1						1						2									6	
Brachychiton acerifolius		1						1								2												1						1			13	1	5
Callicoma serratifolia	7			1		5							1	1		1																2					3		
Callistemon salignus																10																					10		
Casuarina Cunninghamiana																1													1								1	1	
Claoxylon australe																														1									1
Clerodendron tomentosum																													2								10	8	
Croton Verreauxii		1														10	2						3					1				1	1		8	11	1	9	12
Cryptocarya erythroxylon	4	2	4	4	5		3		1	3			1	4	4		1		3			2	5	5	4	14	4	5	9	8	3	8	2				29	51	28
Cryptocarya glaucescens		1													1	1				1	1		7	4	1			2	1	1	1	4			2	21	4	17	28
Cryptocarya microneura		1	1					1						1					18	2			1			1		1	2	1		2	2	1	7	2	8	12
Cryptocarya obovata		2	2						2	2										8		1	13	4		2		3	4	11		3	1		4	5	4	28	31
Cryptocarya patentinervis							3		3										1				1	4	2					2							5	7	10
Daphnandra micrantha	1						4	1						1									1	1		2	1	3	15	1	2	8		1	4	2	7	32	4
Diospyros Cargillea	1	1										1	2	1									1				15		1	1		2	2	3	8	21		
Diospyros pentamera	1	1								1													1		3	13	9	12	9		2	7		3	8	4	37	55	14
Diploglottis Cunninghamii	8	7		3	1		2	1		1			3	7	1		1						1		1	10	1		5	2		40	18		26	29	1	149	101
Doryphora sassafras		22	14		3	12		2	1		1	2		11	14		1		15	5			14	3				1	14	8	1	1	1	1	1		3	18	16
Drimys insipida		1							7																												3		
Dysoxylum Fraseranum																1									2												2	7	2
Enretia acuminata		1														1										1		1	3	2				1			1		
Elaeocarpus reticulatus																													2										
Elaeocarpus obovatus																			1																		1		
Elaeodendron australe																													2								1		
Endiandra discolor																						1			6	1		2			1						1		
Eucalyptus saligna	1																														3						13	1	
Emmenosperma alphitonioidea																						1	1			1								1			1		
Eugenia australis		2																				2	9	3	2	8	14	1	13	3	12	1		1		8	1	5	
Eugenia Smithii	1	3			4			1					1	1	3					1	3				2	1		2	2								20	41	34
Evodia micrococca var. pubescens																3	3											2	?	1	2	2	1	4	1	5	3	3
Eupomatia laurina		1												1											2	3		2	?	1	2	?	1				6	13	3
Ficus stephanocarpa										1						3																					3	1	
Guoia semiglauca		1	2				1						1			3	3		2	6	3	1	2	2	1	5		3	6	13		3	4		5	18	12	31	42
Hymenosporum flavum													2			1							1		2	1											4	3	
Laportea gigas																9	2								3												12	2	
Litsea dealbata					1	6		6		1				1								1	1					1	3	14		7			2	2	2	16	28
Lomatia arborescens																3																					3		
Myrtus Beckleri																			1								1							1	2		1	2	2
Oritea excelsa	4	1	13	1	2	23		2	1				3	4	30							1			1	4		4	8	17	4	6	1	3	6	8	21	33	93
Pennantia Cunninghamii																																1					1	1	
Phyllanthus Ferdinandi																						1															1		
Polyosma Cunninghamii	2	3	7	1	1		2		25				1	2														7	12	43	2	3	10	1	1	6	16	22	91
Psychotria loniceroides		1												2	1		2			5						4		1		2		1					1	13	2
Quintinia Sieberi																																						2	1
Rapanea Howittiana																																1					1		
Rhodamnia trinervia																				1	1	1							1		3					4	2	1
Schizomeria ovata	8		1	1	2								2	4					7	4		8			10	6		6	1		3	2		2	1	47	20	1
Scolopia Brownii																			1		1																1		1
Sideroxylon australe		2					1																7		1			4	9	5					1	2	6	19	7
Sloanea australis	3	6	5		4	11			5	2			3	1	5					1		3	2		3	10	1	1	6	14	5	2		2	6	9	22	37	51
Stenocarpus salignus	1	1	1			5														2	3		5				1			3			2			1	8	15
Syncarpia laurifolia	2		1													1	1		2			6			3					2			3			19	1	1
Synoum glandulosum		2		2	2	7		1					1	1	1					1			4	1		4	1		2	1					2		3	14	11
Trietenia laurina			1										2	1		2			1	2		3						4									10	3	3
Trochocarpa laurina					2											1			1	2			5		1	4		1									3	14	
Charieses Moorei		1			1																		1			1			2									6	
Weinmannia rubifolia																2																						2	
Wilkiea macrophylla		2																	2	1		1	4	1		2	1		2			1				1	13	3

TABLE 3.

Numbers of Lianes in quadrat areas.

Quadrat Area Numbers.	1			2		3			4		5			6			7			8			9			10			11			12			Total		
Heights.	>30'	3-30'	<3'	>30'	3-30'	>30'	3-30'	<3'	>30'	3-30'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'	>30'	3-30'	<3'
Aphanopetalum resinosum														2						1	3		2												3	5	
Celastrus australis																							1													1	
Chilocarpus australis	2	1	3																							3						1	2	2	6	3	5
Cissus antarctica	8		1	4	3	2			3		2		1	6	2	2				1	3		4	1		12	2	11	2	1		1	1		45	9	19
Cissus hypoglauca	7	1				1			1		3									3			3			6	1		4			2	1		30	3	
Clematis aristata		1	1																		1														2	1
Dioscorea transversa											1			1							2											2	3		6	3
Embelia australasica																	1									1									1	2	
Eustrephus latifolius																1																				1
Ficus Henneana																							1												1	
Lyonsia straminea	2	4	2		2	2		1		1	1	4		2	2					1	2			1	2	1	2								7	18	7
Malaisia tortuosa		6				1	2	1									1														1				2	9	1
Morinda jasminoides			3				3					1						1		2				2				14	1	3	4	1	1	3	5	10	24
Palmeria scandens	5	7	41		4	23				2		2	15	2				1	1	2			2	3	8		14	51		1	2	3		16	14	32	159
Piper Novae-Hollandieae	1	1			2		1			3																2	1								4	7	
Rhipogonum album																					13	5	1	2	1		4	7		11	7		3		1	30	23
Rubus Moorei																					1			1	1		1									3	1
Smilax australis		2			1		1	1	1						1			1	2		6					1	1								3	12	3
Tecoma australis			1													1								1								1			1	1	2
Tylophora barbata		1								1					1																					3	

TABLE 4.

Frequencies of Ferns and other Ground Flora Species in Quadrat Areas.

VN, very numerous; N, numerous; F, frequent; S, scanty; R, rare.

(The ground flora species were not recorded in areas 11 and 12.)

Quadrat area	1	2	3	4	5	6	7	8	9	10
Pteridophytes.										
Adiantum affine			S					S		
formosum						S			S	
hispidulum	N									
Alsophila Leichhardtiana ..	N	N		N	N	S			S	
Arthropteris Beckleri					S					
tenella	S		N	S	S	S		S	S	N
Asplenium adiantoides		S		S	S	S	S		S	S
nidus	S	S		S	F	F	S			S
Athyrium umbrosum						N				S
Blechnum capense		S								
cartilagineum	N	S	S	S	S	N		S	S	
Patersoni	F	S		S	F					
Cyclophorus confluens			S			S			S	S
Davallia pyxidata				S	S				S	
Dennstaedtia davallioides ..						S	S			
Dicksonia antarctica		S								
Doodia aspera							S	S		
Dryopteris acuminata		S			S					
decomposita	N	F	N	F	N	F	F	N	F	VN
parasitica						S				
Pellaea falcata		S	S		F			S		
Platycerium bifurcatum	F	S	S	S	S	S	S	S	S	S
Pleopeltis Brownii					S	S		S	S	
pustulata	F	F	S	S	N	F		S	S	N
Pteris umbrosa			S		S					
Trichomanes caudatum		R		F						
Angiosperms.										
Aneilema acuminatum						S		S	S	
Calanthe veratrifolia								S		
Citriobatus multiflorus	S	S	N	S	S	N	N	F	F	S
Colocasia macrorrhiza	F								S	S
Gahnia aspera			S				S			S
Gymnostachys anceps									S	
Lomandra montana		S	F	F	N	F	F	F	F	F
Oplismenus imbecillus								S		
Pollia crispata						S		S		

TABLE 5.
Density of the Flora in the Quadrat Areas.

Quadrat area.	Number of Plants (excluding Ferns and less important Herbs) per 100 Square Feet.								Percentages.					
	Trees.	Saplings.	Shrubs.	*Alsophila*.	Total (of trees, saplings, shrubs and *Alsophila*).	*Citriobatus*.	*Lomandra*.	Seedlings (of shrubs and trees).	Trees.	Saplings.	Shrubs.	*Alsophila*.	*Citriobatus*.	Seedlings.
1	3·11	2·62	1·62	7·9	15·25	0·73	2·9	3·2	20·4	17·1	10·7	51·8	3·9	30·3
2	3·38	5·36	0·59	8·5	17·83	0·4	1·58	15·9	18·9	30·1	3·3	47·7	11·1	63·0
3	6·03	5·08	0·63	—	11·74	6·66	2·5	17·6	51·4	43·2	5·3	—	31·9	59·9
4	1·9	0·63	0·31	15·2	18·04	0·63	0·32	1·0	10·5	3·5	1·7	84·2	3·3	26·0
5	3·17	4·23	1·58	8·3	17·28	0·53	5·4	8·2	18·3	24·5	9·1	48·0	2·2	47·7
6	9·15	4·86	—	0·53	14·54	5·29	2·3	0·5	62·9	33·4	—	3·7	23·9	3·4
7	3·4	11·3	3·85	—	18·55	0·97	3·4	8·8	18·3	60·9	20·7	—	4·2	32·3
8	5·55	11·5	2·38	—	19·43	3·96	3·8	3·9	28·4	59·2	12·3	—	14·6	16·7
9	6·80	11·9	2·15	—	20·85	3·17	1·5	3·8	32·6	57·1	10·3	—	12·4	15·4
10	6·84	15·3	1·09	0·16	23·39	11·1	2·6	18·1	29·1	65·1	4·6	0·7	29·1	43·8
11	4·25	5·34	5·98	0·29	15·86	3·3	2·4	3·8	26·8	33·7	37·7	1·8	15·3	19·5
12	2·57	7·34	3·17	1·09	14·17	9·8	4·9	14·9	18·1	51·8	22·2	7·7	34·0	53·2

The percentages of the trees, saplings, shrubs and *Alsophila* are expressed as the percentage of the total number of plants of these four groups. The percentage of *Citriobatus* is expressed as the percentage of the total number of all the groups except the seedlings. The percentage of seedlings is expressed as the percentage of the total number of the tree, sapling, shrub and seedling groups.

TABLE 6.
List of Rain-Forest Species observed in the Upper Chichester and Manning River Valleys.

Species.	Upper Chichester.	Upper Manning.	Species.	Upper Chichester.	Upper Manning.
Pteridophytes.			*Hypolepis tenuifolia* Bernh. ..	X	
Cyatheaceae.			*Platycerium bifurcatum* C.Chr. ..	X	
Alsophila Leichhardtiana F.v.M.	X		*Pteris umbrosa* R.Br.	X	
Dicksonia antarctica Labill. ..	X		Gleicheniaceae.		
Polypodiaceae.			**Gleichenia flabellata* R.Br. ..	X	
Adiantum affine Willd.	X		*Angiosperms.*		
formosum R.Br.	X		Monocotyledons.		
hispidulum Sw.	X		Cyperaceae.		
Arthropteris tenella J.Sm. ..	X		*Gahnia aspera* Spreng.	X	
Asplenium adiantoides C.Chr. ..	X		*melanocarpa* R.Br.	X	
nidus L.	X		Araceae.		
Athyrium umbrosum Presl. ..	X		**Typhonium Brownii* Schott. ..		X
Blechnum capense Schlecht. ..	X		Liliaceae.		
cartilagineum Sw.	X		*Lomandra hystrix* Fraser & Vickery	X	
discolor Keys	X		*montana* Fraser & Vickery ..	X	
Cyclophorus serpens C.Chr. ..	X		*Smilax australis* R.Br.		X
Diplazium japonicum Beddome	X				
Doodia aspera R.Br.	X				
Dryopteris decomposita O. Kuntze	X				
parasitica O. Kuntze ..		X			

* Species not found in the Williams River valley.

TABLE 6.—*Continued.*

Species.	Upper Chichester.	Upper Manning.
Dioscoreaceae.		
Dioscorea transversa R.Br. ..		X
Dicotyledons.		
Piperaceae.		
Piper Novae-Hollandiae Miq. ..	X	
Ulmaceae.		
**Aphananthe philippinensis* Planch.		X
Trema cannabina Lour.		X
Moraceae.		
Cudrania javanensis Tréc. ..		X
**Ficus macrophylla* Desf. ..		X
stephanocarpa Warb. ..	X	X
Malaisia tortuosa Blanco ..	X	
**Pseudomorus Brunoniana* Bur. ..		X
Urticaceae.		
Laportea gigas Wedd.		X
* *photiniphylla* Wedd.		X
Proteaceae.		
Orites excelsa R.Br.	X	X
Stenocarpus salignus R.Br. ..	X	
Santalaceae.		
**Santalum obtusifolium* R.Br. ..		X
Amarantaceae.		
**Deeringia celosioides* R.Br. ..		X
Ranunculaceae.		
Clematis glycinoides DC. ..	X	X
Menispermaceae.		
Legnephora Moorei Miers ..		X
Sarcopetalum Harveyanum F.v.M.		X
Stephania hernandifolia Walp. ..		X
Anonaceae.		
Eupomatia laurina R.Br. ..	X	
Monimiaceae.		
Daphnandra micrantha Benth. ..	X	X
Doryphora sassafras Endl. ..	X	
Wilkiea macrophylla A.DC. ..	X	X
Palmeria scandens F.v.M. ..	X	
Winteraceae.		
Drimys insipida Druce	X	
Lauraceae.		
Cryptocarya glaucescens R.Br. ..	X	X
microneura Meissn.	X	X
obovata R.Br.	X	
Cryptocarya patentinervis F.v.M.	X	
Endiandra Muelleri Meissn. ..	X	
Litsea dealbata Nees		X
* *zeylandica* Nees		X
Capparidaceae.		
**Capparis nobilis* F.v.M.		X
Pittosporaceae.		
Citriobatus multiflorus A.Cunn.	X	X
Hymenosporum flavum F.v.M. ..	X	
Pittosporum revolutum Ait. ..		X
undulatum Andr.	X	

Species.	Upper Chichester.	Upper Manning.
Cunoniaceae.		
Ackama Muelleri Benth. ..	X	X
Aphanopetalum resinosum Endl.		X
Callicoma serratifolia Andr. ..	X	
Schizomeria ovata D.Don. ..	X	
Rosaceae.		
Rubus moluccanus L.		X
Moorei F.v.M.		X
rosaefolius Sm...		X
Leguminosae.		
Acacia elata A.Cunn.	X	
melanoxylon R.Br.	X	
mollissima Willd.		X
**Cassia sophora* L. var. *schinifolia* Benth.		X
Lonchocarpus Blackii Benth. ..	X	X
Pithecolobium pruinosum Benth.		-X
**Tephrosia purpurea* Pers. ..		X
Rutaceae.		
Acronychia laevis R. & G.Forst.	X	X
Evodia micrococca F.v.M. ..		X
**Geijera salicifolia* Schott. ..		X
Meliaceae.		
Cedrela australis F.v.M. ..	X	X
Dysoxylum Fraseranum Benth.	X	X
**Melia Azedarach* L.		X
Synoum glandulosum A.Juss. ..	X	X
Euphorbiaceae.		
**Alchornea ilicifolia* J.Muell. ..		X
Baloghia lucida Endl.	X	X
Breynia oblongifolia J.Muell. ..	X	X
Claoxylon australe Baill. ..		X
Croton Verreauxii Baill. ..	X	X
Glochidion Ferdinandi J.Muell.	X	
**Mallotus philippinensis* J.Muell.		X
Anacardiaceae.		
Rhodosphaera rhodanthema Engl.		X
Celastraceae.		
Celastrus Cunninghamii F.v.M.		X
Elaeodendron australe Vent. ..		X
Sapindaceae.		
Alectryon subcinereus Radlk. ..	X	X
* *subdentatus* Radlk.		X
Diploglottis Cunninghamii Hook.	X	X
Dodonaea triquetra Wendl. ..		X
**Elattostachys nervosa* Radlk. ..		X
Guoia semiglauca Radlk. ..	X	X
Rhamnaceae.		
Alphitonia excelsa Reiss. ..		X
Vitaceae.		
Cayratia clematidea Domin. ..		X
Cissus antarctica Vent.	X	X
hypoglauca A.Gray.	X	X
Tetrastigma nitens Planch. ..		X

TABLE 6.—*Continued.*

Species.	Upper Chichester.	Upper Manning.	Species.	Upper Chichester.	Upper Manning.
Elaeocarpaceae.			Myrsinaceae.		
Elaeocarpus obovatus G.Don. ..		X	*Embelia australasica* Mez. ..		X
reticulatus Sm.	X		*Rapanea variabilis* Mez. ..		X
Sloanea australis F.v.M... ..	X		Ebenaceae.		
* *Woollsii* F.v.M.	X		*Diospyros Cargillia* F.v.M. ..		X
Malvaceae.			Sapotaceae.		
Hibiscus heterophyllus Vent. ..	X		*Sideroxylon australe* Benth. ..	X	X
Stereuliaceae.			Oleaceae.		
Brachychiton acerifolius F.v.M.	X	X	**Jasminum simplicifolium* G.Forst.		X
**Tarrietia actinophylla* Bailey ..		X	*Notelaea venosa* F.v.M.		X
Violaceae.			Apocynaceae.		
Hymenanthera dentata R.Br. ..		X	**Alyxia ruscifolius* R.Br. ..		X
Myrtaceae.			*Lyonsia Brownii* Britten ..		X
Backhousia myrtifolia Hook. &			Boraginaceae.		
Harv.	X		*Ehretia acuminata* R.Br. ..	X	X
* *sciadophora* F.v.M.		X	Verbenaceae.		
Callistemon salignus DC. ..		X	*Clerodendron tomentosum* R.Br.	X	X
**Decaspermum paniculatum* Baill.		X	Solanaceae.		
Eucalyptus saligna Sm. ..	X	X	*Duboisia myoporoides* R.Br. ..	X	X
Eugenia australis Wendl. ..	X	X	Bignoniaceae.		
Smithii Poir.	X	X	*Tecoma australis* R.Br.	X	
* var. *minor* Maiden & Betche		X	Acanthaceae.		
Myrtus Beckleri F.v.M.	X	X	*Eranthemum variabile* R.Br. ..		X
Rhodamnia trinervia Blume ..		X	**Justicia procumbens* L.		X
Rhodomyrtus psidioides Benth. ..	X		Myoporaceae.		
Syncarpia laurifolia Ten. ..	X		**Myoporum acuminatum* R.Br. ..		X
Tristania conferta R.Br. ..	X		Rubiaceae.		
laurina R.Br.	X		*Morinda jasminoides* A.Cunn. ..	X	X

TABLE 7.

List of Species occurring in the Sub-antarctic Rain-Forest.

VC, very common; C, common; LC, locally common; F, frequent; S, scanty; R, rare.

Species.	Frequency.	Trees.	Shrubs.	Herbs.	Lianes.	Epiphytes.	Species.	Frequency.	Trees.	Shrubs.	Herbs.	Lianes.	Epiphytes.
Pteridophytes.							*Blechnum Patersoni*						
Hymenophyllaceae.							Mett.	LC			X		
Hymenophyllum flabellatum Labill. ..	S			X			*Dennstaedtia davallioides* Moore ..	F			X		
Cyatheaceae.							*Dryopteris acuminata*						
Dicksonia antarctica							Watts	LC			X		
Labill.	VC		X				*Histiopteris incisa*						
Polypodiaceae.							J.Sm.	F			X		
Arthropteris tenella							*Hypolepis tenuifolia*						
J.Sm.	S			X			Bernh.	F			X		
Asplenium bulbiferum							*Pleopeltis pustulata*						
Forst.	LC			X			Moore	S			X		

TABLE 7.—*Continued.*

Species.	Frequency.	Trees.	Shrubs.	Herbs.	Lianes.	Epiphytes.
Polypodium Billardieri C.Chr.	F			X		
Polystichum aculeatum Schott.	VC			X		
Pteris umbosa R.Br.	F			X		
Angiosperms.						
Monocotyledons.						
Gramineae.						
Poa caespitosa G.Forst.	S			X		
Cyperaceae.						
Uncinia riparia R.Br.	S			X		
Liliaceae.						
Lomandra longifolia Labill.	F			X		
Smilax australis R.Br.	C				X	
Iridaceae.						
Libertia pulchella Spreng.	S			X		
Orchidaceae.						
Dendrobium falcorostrum Fitzg. ..	R					X
Dicotyledons.						
Fagaceae.						
Nothofagus Moorei Oerst.	VC	X				
Urticaceae.						
Australina pusilla Gaud.	F			X		
Elatostemma reticulatum Wedd. ..	LC			X		
Urtica incisa Poir. ..	F			X		
Proteaceae.						
Lomatia arborescens Fraser & Vickery	F		X			
Caryophyllaceae.						
Stellaria flaccida Hook.	F			X		
Ranunculaceae.						
Clematis aristata R.Br.	S				X	
Winteraceae.						
Drimys purpurascens J.Vickery ..	S		X			
Monimiaceae.						
Atherosperma moschatum Labill. ..	F	X				
Doryphora sassafras Endl.	F	X				

Species.	Frequency.	Trees.	Shrubs.	Herbs.	Lianes.	Epiphytes.
Hedycarya angustifolia A.Cunn.	F		X			
Cruciferae.						
Cardamine hirsuta L.						
var. *tenuifolia* F.v.M.	S			X		
Saxifragaceae.						
Quintinia Sieberi A.DC.	R	X				
Pittosporaceae.						
Pittosporum undulatum Andr.	S	X				
Citriobatus multiflorus A.Cunn.	LC		X			
Cunoniaceae.						
Weinmannia rubifolia Benth.	R	X				
Rosaceae.						
Rubus moluccanus L.	S				X	
parvifolius L. ..	S		X			
Acaena sanguisorba Vahl.	F			X		
Vitaceae.						
Cissus antarctica Vent.	S				X	
Elaeocarpaceae.						
Elaeocarpus holopetalus F.v.M.	F	X				
Flacourtiaceae.						
Streptothamnus Beckleri F.v.M.	F				X	
Violaceae.						
Hymenanthera dentata R.Br.	S		X			
Epacridaceae.						
Trochocarpa laurina R.Br.	LC	X	X			
Oleaceae.						
Notelaea venosa F.v.M.	F		X			
Apocynaceae.						
Lyonsia Brownii Britten	S				X	
Scrophulariaceae.						
Veronica notabilis F.v.M.	F			X		
Rubiaceae.						
Galium umbrosum Sol.	S			X		

TABLE 8.

Results of Quadrats Examined in the Sub-antarctic Rain-Forest.

	Group 1. (10 quadrats.)			Group 2. (17 quadrats.)		
	>30 feet.	3–30 feet.	<3 feet.	>30 feet.	3–30 feet.	<3 feet.
Acacia melanoxylon			1			
Asplenium bulbiferum			1			
Doryphora sassafras..				5	7	
Drimys purpurascens		1	2		1	
Eucalyptus campanulata		1				
pauciflora	2					
Dysoxylum Fraseranum				1		1
Elaeocarpus holopetalus		1		1		
Hedycarya angustifolia					2	
Lomatia arborescens		11	3		1	
Notelaea venosa			1		1	
Nothofagus Moorei	12	6	1	19	5	
Trochocarpa laurina			4		6	
Total number of plants	14	20	13	26	23	1

TABLE 9.

Frequencies of Trees, Saplings and Shrubs in the Quadrat Areas examined in the Sub-antarctic Rain-Forest.

Quadrat Area.	Number of Plants per 100 Square Feet.					Percentages.		
	Trees.	Saplings.	Shrubs.	Saplings + Shrubs.	Total.	Trees.	Saplings.	Shrubs.
Group 1 (10 quadrats) ..	2·4	3·2	2·0	5·2	7·6	31·8	42·1	26·3
Group 2 (17 quadrats) ..	2·4	2·1	0·1	2·2	4·6	52·2	45·6	2·2

TABLE 10.

List of Species Recorded from Comboyne, Dorrigo, Port Macquarie, Upper Hastings River and Krambach Mountain, which have not been observed in the Williams River Valley.

	Comboyne.	Dorrigo.	Port Macquarie.	Upper Hastings River.	Krambach Mountain.
Pteridophyta.					
Polypodiaceae.					
Arthropteris obliterata J.Sm.	X				
Dryopteris Queenslandica Domin.	X				
Gymnosperms.					
Taxaceae.					
Podocarpus elata R.Br. ..			X		
Pinaceae.					
Araucaria Cunninghamii Ait.		X			
Angiosperms.					
Monocotyledons.					
Palmeae.					
Archontophoenix Cunninghamiana Wendl. et Drude		X	X		
Calamus Muelleri Wendl.		X			
Linospadix monostachyus Wendl.		X			
Araceae.					
Pothos longipes Schott. ..	X	X			
Flagellariaceae.					
Flagellaria indica L. ..			X		
Liliaceae.					
Cordyline stricta Endl. ..	X		X		
Drymophila Moorei Baker	X				
Kreyssigia multiflora Reichb.	X	X	X		
Rhipogonum discolor F.v.M.		X			
Dicotyledons.					
Moraceae.					
Ficus Bellingeri C.Moore ..		X			
macrophylla Desf. ..	X	X			X
rubiginosa Desf. ..	X				
Pseudomorus Brunoniana Bur.		X			X
Urticaceae.					
Elatostemma stipitatum Wedd.	X	X			
Laportea photiniphylla Wedd.		X			
Proteaceae.					
Helicia glabrifolia F.v.M.	X	X			
Youngiana F.v.M. ..		X			
Menispermaceae.					
Legnephora Moorei Miers.	X				
Amarantaceae.					
Deeringia celosioides R.Br.					X
Phytolaccaceae.					
Codonocarpus attenuatus H.Walter					X
Monimiaceae.					
Daphnandra tenuipes Perk.	X				
Piptocalyx Moorei Oliv. ..	X	X			
Lauraceae.					
Cinnamomum Oliveri Bailey	X				
virens R.T.Baker ..	X				
Cryptocarya Meissneri F.v.M.	X	X			
Endiandra Sieberi Nees ..	X				
Capparidaceae.					
Capparis nobilis F.v.M. ..	X		X		
Saxifragaceae.					
Anopterus glandulosus Labill.			X		
Macleayanus F.v.M. ..	X				
Cuttsia viburnea F.v.M. ..	X	X			
Quintinia Verdonii F.v.M.	X				
Cunoniaceae.					
Ceratopetalum apetalum D.Don.	X				
Geissois Benthami F.v.M. ..	X				
Leguminoseae.					
Castanospermum australe A.Cunn.	X	X			
Milletia australis Benth. ..		X			
Rutaceae.					
Acronychia Baueri Schott.	X	X			X
melicopoides F.v.M. ..		X			
Bosistoa euodiformis F.v.M.	X				
Flindersia Oxleyana F v.M.		X			
Geijera salicifolia Schott.	X				
Xanthoxylum brachyacanthum F.v.M. ..					X
Simarubaceae.					
Guilfoylia monostylis F.v.M.		X			
Meliaceae.					
Dysoxylum rufum Benth.	X				X
Euphorbiaceae.					
Acalypha nemorum F.v.M.				X	
Alchornea ilicifolia J.Muell.				X	X
Cleistanthus Cunninghamii J.Muell.			X	X	
Croton insularis Baill. ..		X			
phebalioides F.v.M. ..					X
Celastraceae.					
Denhamia pittosporoides F.v.M.	X				
Sapindaceae.					
Castanospora Alphandi F.v.M.		X			
Elattostachys nervosa Radlk.				X	
Harpullia pendula Planch.		X			
Sarcopteryx stipitata Radlk.	X	X			
Akaniaceae.					
Akania Hillii Hook.f. ..	X	X			

TABLE 10.—*Continued.*

	Comboyne.	Dorrigo.	Port Macquarie.	Upper Hastings River.	Krambach Mountain.
Elaeocarpaceae.					
Aristotelia australasica F.v.M.		X			
Sloanea austroqueenslandica Domin.	X				
Woollsii F.v.M. ..	X				
Sterculiaceae.					
Ruelingia pannosa R.Br. ..		X			
Sterculia lurida Benth. ..					X
Tarrietia actinophylla Bailey	X	X			
argyrodendron Benth. ..				X	X
Myrtaceae.					
Backhousia sciadophora F.v.M.					X
Eucalyptus microcorys F.v.M.				X	
Eugenia Cootminiana C.Moore	X				
corynantha F.v.M. ..	X				
cyanocarpa F.v.M. ..	X				
Myrtus rhytisperma F.v.M.		X			
Melastomaceae.					
Melastoma malabathricum L.		X			
Oleaceae.					
Olea paniculata R.Br. ..	X				
Apocynaceae.					
Alyxia ruscifolius R.Br...	X				
Tabernaemontana orientalis R.Br.		X			
Asclepiadaceae.					
Hoya australis R.Br. ..		X			
Gesneraceae.					
Fieldia australis A.Cunn...	X				
Acanthaceae.					
Justicia procumbens L. ..				X	
Myoporaceae.					
Myoporum acuminatum R.Br.	X	X			
Rubiaceae.					
Psychotria daphnoides A.Cunn.		X			